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Assessment of carbapenem-resistant Enterobacteriaceae—plate formula and quality control procedure

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Abstract

Aims: To assess a cost-effective in-house selective plate formula for actively screening carbapenem-resistant Enterobacteriaceae (CRE).

Methodology and results: The in-house formula included CHROMagar™ Orientation, meropenem, and ingredients present in the Mac-Conkey formula, such as bile salts and crystal violet (pH 6.9-7.2). American Type Culture Collection strains and 200 clinical strains were used to validate the plate formula. The CRE plates had a sensitivity of 97.4% and a specificity of 98.8% with ATCC andor clinical strains used in the quality control procedure. A point prevalence survey among the 18 inpatients at Viet-Tiep hospital ICU using fecal swabs plated at the in-house agar plate showed a CRE prevalence of 44.4%.

Conclusion: The in-house plate had high sensitivity and specificity, particularly for *Escherichia coli* and the KESC group (*Klebsiella spp*., *Enterobacter spp*., *Serratia marscescens*, and *Citrobacter spp*.), and it may be widely applied as an alternative to other ready-to-use commercial plates.

Significance and impact of the study: The formula developed in the present study may facilitate the early detection and isolation of CRE and decrease transmission, particularly in low- and middle-income countries with a high rate of CRE colonization and limited access to ready-to-use commercial plates.

KEYWORDS
biotechnology, detection, diagnosis, Enterobacteria, quality control

1 | 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

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CRE colonization at 12 hospitals in Vietnam, 52% were CRE colonized (1165/2233 patients tested), most commonly *Klebsiella pneumoniae* (*K. 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)s 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 (Hindiyeh 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-chromid-carba, 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).

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–1705[a]	Metallic blue
E.coli ATCC® BAA–2340[a]	Reddish
Clinically isolated strains (*E. coli*/*K. pneumoniae*) confirmed KPC and/or NDM–1 mutations by PCR[a]	In-house bacterial strains

[a]Our suggestion with CRE ATCC strains.

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.

- 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.

TABLE 2 The in-house CRE medium formula developed in the present study (pH 6.9-7.2 at 25°C, adjusted with NaOH or 0.1 N HCl).

Component	Quantity	Final concentration
CHROMagar™ Orientation	33 g	
Meropenem (2000 µg/ml)	1 ml	2 µg/ml
Bile salt (15%)	10 ml	0.15%
Crystal violet (1 mg/ml)	1 ml	1 mg/L
Distilled water	Up to 1 L	

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

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/metallic blue	Excellent	Excellent
K. pneumoniae ATCC BAA 1706 (**S**)			**Inhibited**
K. pneumoniae with KPC/NDM-1 or both (R)			Good to luxuriant
E. faecalis ATCC 29212	Excellent/turquoise blue	**Inhibited**	**Inhibited**
S. aureus ATCC 295923	Excellent/golden, opaque, small	**Inhibited**	**Inhibited**

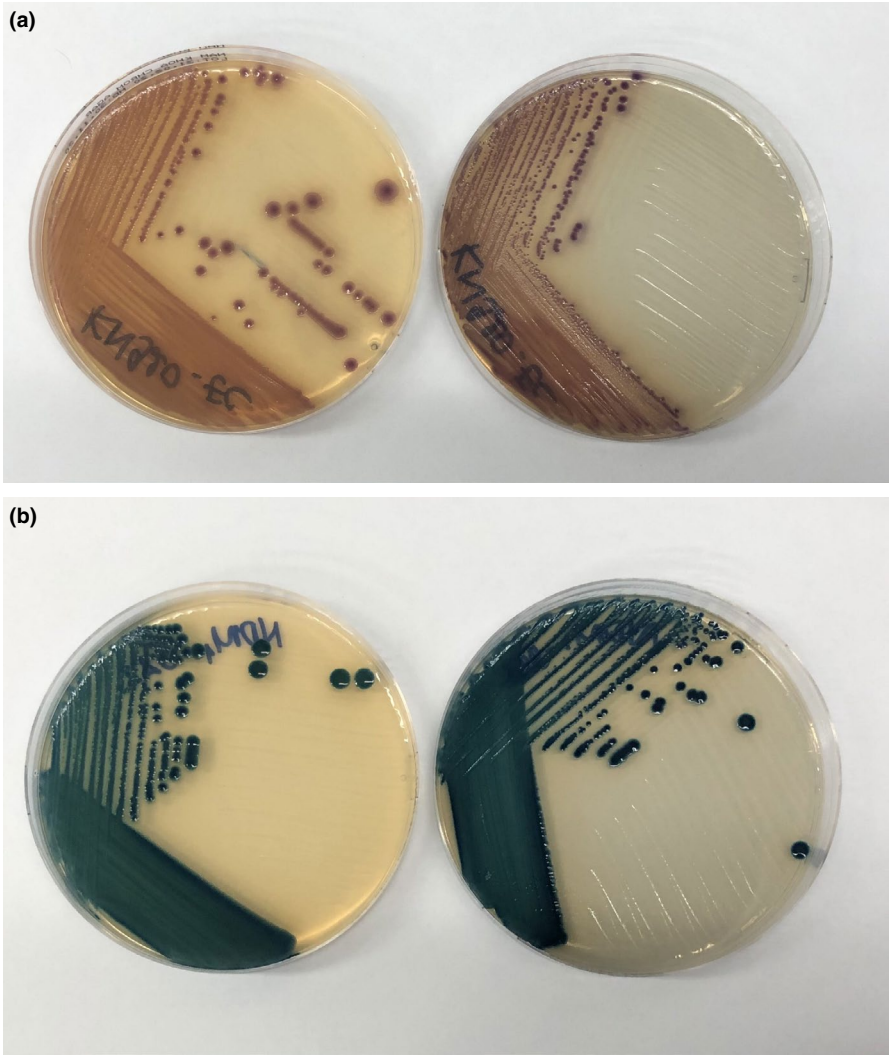

FIGURE 1 The bacterial colony colors were the same as in (a, c) CHROMagar without any supplement and (b,d) CRE in-house plate
Klebsiella pneumoniae - KP1705 (resistant clinical strain), a, b
E.coli - KN920 (resistant clinical strain) c, d

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 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]).

	PCR (+)	PCR (–)	Total PCR
CRE (+)	111	1	112
CRE (–)	3	85	88
Total CRE	114	86	200

Sensitivity = 97.4%; Specificity = 98.8%.

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	0.0	100
No	66.7	33.3
Current infectious diseases		
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

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, $ZnSO_4$ (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) We focused on KPC and NDM mutants in our formula to obtain high sensitivity and specificity.

Quality control procedures have been described in all commercial CRE plates and all procedures require ATCC strains. The quality control procedure described in this study was developed using a combination of ATCC strains available in medical laboratories and clinically isolated strains with mutations (KPC/NDM-1 or both) as confirmed by the CDC standard PCR protocols (Centers for Disease Control & Prevention, 2011). The colony colors were the same as those described for CHROMagar. Only *E.coli* was well identified by color check and the other strains, for example, the KESC group (*Klebsiella*, *Enterobacter*, *Serratia*, and *Citrobacter*), required further testing for differentiation (CHROMagar, 2017).

ChromID CARBA (Biomerieux) has a sensitivity of 96.5% and a specificity of 100%. Mac Conkey plus imipenem has a sensitivity of 89.5% and specificity of 70.3% (Vrioni et al., 2012). Our CRE in-house formula is compatible with CHROMagar, some components in Mac Conkey, and meropenem/imipenem. The CRE in-house formula has a sensitivity of 97.4% and a specificity of 98.8%, which is higher than that reported for Mac Conkey plus imipenem and similar to that of ChromID CARBA.

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.

TABLE 6 Interpretation of quality control results for the CRE in-house formula.

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**

In our previous study, the CRE colonization prevalence at 12 hospitals in Vietnam was 52% (1165/2233 patients tested), showing a significant correlation between CRE colonization, hospital-acquired infection, and mortality and were most common colonizing Enterobacteriaceae were *Klebsiella pneumoniae* (*K. pneumoniae*), *Escherichia coli* (*E. coli*), and Enterobacter spp. and (Tran et al., 2019). The present study described the development and application of an affordable and innovative plate ready for the emerging situation 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 ATTC and/or clinically isolated strains. This in-house medium may serve as an alternative low-cost option with similar performance to commercially available ones.

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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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APPENDIX A1

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 (HSCĐ)	*Escherichia coli*	32	R	32	R	KPC (-)/NDM1 (+)
2	KN.091	I01.1346	085/0515	Y51	M	Urine	BV. NTP (HSCĐ)	*Escherichia coli*	4	R	128	R	KPC (–)/NDM1 (+)
3	KN.091	I01.1346	085/0515	Y51	M	Urine	BV. NTP (HSCĐ)	*Escherichia. coli*	4		1	S	KPC (–)/NDM1 (–)
4	KN.094	I01.1607	952/0715	Y84	M	LRI (Sputum)	BV. NTP (Nội 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 (Nội tiết)	*Escherichia coli*	16	R	4	R	KPC (–)/NDM1 (+)
7	KN.215	I01.2968	383/1116	Y79	F	LRI (Sputum)	BV. NTP (Nội hô hấp)	*Escherichia coli*	32	R	8	R	KPC (–)/NDM1 (+)
8	KN.230	I01.3055	2222 DV/1216	Y60	M	Pus	BV 7A	*Escherichia coli*	64	R	16	R	KPC (–)/NDM1 (+)
9	KN.223	I01.3081	2251DV/1216	Y60	M	Pus	BV 7A	*Escherichia coli*	32	R	16	R	KPC (–)/NDM1 (+)
10	KN.287	I01.3315	1776/0417	Y55	M	Phân	BV. NTP (HSCĐ)	*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 (Sputum)	BV. Nguyễn Trãi	*Escherichia coli*	64	R	32	R	KPC (–)/NDM1 (+)
13	KN.321	I01.3458	379DV/17	Y90	M	LRI (Sputum)	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 (Sputum)	BV. NTP (HSCĐ)	*Escherichia coli*	2	I	0.25	S	KPC (–)/NDM1 (+)
16		I01.5081	073/1018	Y28	M	Urine	BV. NTP (Nội cơ xương khớp)	*Escherichia coli*	< 0,25	S	< 0,25	S	KPC (–)/NDM1 (–)
17		I01.5082	084/1018	Y45	F	Urine	BV. NTP (Nội thận)	*Escherichia coli*	< 0,25	S	< 0,25	S	KPC (–)/NDM1 (–)
18		I01.5083	013/1018	Y66	F	Urine	BV. NTP (Nội tim mạch)	*Escherichia coli*	< 0,25	S	< 0,25	S	KPC (–)/NDM1 (–)
19		I01.5085	190/1018	Y43	M	Pus	BV. NTP (Nội 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 (Nội thận)	*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 (Nội cơ xương khớp)	*Escherichia coli*	1	S	< 0,25	S	KPC (–)/NDM1 (–)

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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
29		I01.5097	580/1018	Y77	F	Pus	BV. NTP (Ngoại tổng hợp)	*Escherichia coli*	0.25	S	0.25	S	KPC (–)/NDM1 (–)
30		I01.5100	706/1018	Y60	F	Urine	BV. NTP (Nội cơ xương khớp)	*Escherichia coli*	0.25	S	1	S	KPC (–)/NDM1 (–)
31		I01.5101	707/1018	Y62	F	Urine	BV. NTP (Nội tiết)	*Escherichia coli*	0.25	S	1	S	KPC (–)/NDM1 (–)
32		I01.5102	679/1018	Y69	F	Urine	BV. NTP (Đơn vị lọc máu)	*Escherichia coli*	0.25	S	0.25	S	KPC (–)/NDM1 (–)
33		I01.5103	676/1018	Y43	M	Pus	BV. NTP (GMHS)	*Escherichia coli*	0.5	S	0.25	S	KPC (–)/NDM1 (–)
34		I01.5104	673/1018	Y85	F	Urine	BV. NTP (Ngoại thận tiết niệu)	*Escherichia coli*	0.5	S	< 0,25	S	KPC (–)/NDM1 (–)
35		I01.5105	672/1018	Y50	F	Urine	BV. NTP (Ngoại thận tiết niệu)	*Escherichia coli*	0.5	S	< 0,25	S	KPC (–)/NDM1 (–)
36		I01.5107	760/1018	Y55	M	Urine	BV. NTP (Ngoại thận tiết niệu)	*Escherichia coli*	0.5	S	< 0,25	S	KPC (–)/NDM1 (–)
37		I01.5110	847/1018	Y74	F	Urine	BV. NTP (Nội thần kinh)	*Escherichia coli*	2	S	0.25	S	KPC (–)/NDM1 (–)
38		I01.5113	920/1018	Y63	M	LRI (Sputum)	BV. NTP (Nội hô hấp)	*Escherichia coli*	2	S	1	S	KPC (–)/NDM1 (–)
39		I01.5114	923/1018	Y64	M	LRI (Sputum)	BV. NTP (Lão)	*Escherichia coli*	2	S	1	S	KPC (–)/NDM1 (–)
40		I01.5119	1317/1018	Y87	F	Blood	BV. NTP (Cấp cứu)	*Escherichia coli*	2	S	0.25	S	KPC (–)/NDM1 (–)
41		I01.5120	1318/1018	Y87	F	Blood	BV. NTP (Cấp cứu)	*Escherichia coli*	0.25	S	0.25	S	KPC (–)/NDM1 (–)
42		I01.5121	1319/1018	Y87	F	Blood	BV. NTP (Cấp cứu)	*Escherichia coli*	0.25	S	2	S	KPC (–)/NDM1 (–)
43		I01.5122	1254/1018	Y74	F	LRI (Sputum)	BV. NTP (Nội thần kinh)	*Escherichia coli*	1	S	0.25	S	KPC (–)/NDM1 (–)
44		I01.5123	1481/1018	Y66	F	Pus	BV. NTP (Ngoại tổng hợp)	*Escherichia coli*	1	S	0.25	S	KPC (–)/NDM1 (–)
45		I01.5124	1461/1018	Y35	F	Pus	BV. NTP (GMHS)	*Escherichia coli*	0.5	S	1	S	KPC (–)/NDM1 (–)
46		I01.5125	1446/1018	Y58	M	Pus	BV. NTP (Nội tiết)	*Escherichia coli*	0.5	S	0.5	S	KPC (–)/NDM1 (–)
47		I01.5127	1425/1018	Y71	F	Urine	BV. NTP (Nội tiết)	*Escherichia coli*	0.5	S	0.5	S	KPC (–)/NDM1 (–)
48		I01.5128	1390/1018	Y56	M	Urine	BV. NTP (Cấp cứu)	*Escherichia coli*	0.25	S	0.25	S	KPC (–)/NDM1 (–)
49	KN.079	I02.0244	1712DV/0815	Y 36	F	Pus	BV 7A	*Enterobacter aerogenes*	4	R	1	S	KPC (–)/NDM1 (–)
50	KN.107	I02.0279	383/1015	Y 71	M	LRI (Sputum)	BV. NTP (Nội hô hấp)	*Enterobacter aerogenes*	8	R	1	S	KPC (–)/NDM1 (–)
51	KN.087	I02.0287	2237DV/1015	Y 23	M	Pus	BV 7A	*Enterobacter aerogenes*	2	I	1	S	KPC (–)/NDM1 (–)

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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
52	KN.086	I02.0291	2267DV/1015	Y 36	F	Pus	BV 7A	*Enterobacter aerogenes*	8	R	1	S	KPC (–)/NDM1 (–)
53	KN.112	I02.0485	1246DV	Y56	M	Pus	BV 7A	*Enterobacter aerogenes*	4	R	0.5	S	KPC (–)/NDM1 (–)
54	KN.161	I02.532	1798/0816	Y49	M	LRI (Sputum)	BV. NTP (Nội tiêu hóa)	*Enterobacter aerogenes*	8	R	1	S	KPC (–)/NDM1 (–)
55	KN.088	I03.0609	205/0215	Y80	M	Urine	BV. NTP (Nội cơ xương khớp)	*Klebsiella pneumoniae*	> 128	R	> 128	R	KPC (+)/NDM1 (+)
56	KN.057	I03.0656	639/0315	Y65	M	Pus	BV. NTP (HSCĐ)	*Klebsiella pneumoniae*	8	R	16	R	KPC (+)/NDM1 (–)
57	KN.062	I03.0693	093/0415	Y62	M	LRI (Sputum)	BV. NTP (Nội hô hấp)	*Klebsiella pneumoniae*	4	R	8	R	KPC (–)/NDM1 (+)
58	KN.061	I03.0694	091B/0415	Y49	M	LRI (Sputum)	BV. NTP (Nội hô hấp)	*Klebsiella pneumoniae*	4	R	8	R	KPC (–)/NDM1 (+)
59	KN.064	I03.0709	678/0415	Y63	F	LRI (Sputum)	BV. NTP (HSCĐ)	*Klebsiella pneumoniae*	8	R	4	R	KPC (+)/NDM1 (–)
60	KN.064	I03.0709	678/0415	Y 63	F	LRI (Sputum)	BV. NTP (HSCĐ)	*Klebsiella pneumoniae*	8	R	1	S	KPC (–)/NDM1 (–)
61	KN.089	I03.0710	729/0415	Y 63	F	LRI (Sputum)	BV. NTP (HSCĐ)	*Klebsiella pneumoniae*	4	R	1	S	KPC (–)/NDM1 (–)
62	KN.090	I03.0711	733/0415	Y 63	F	Pus	BV. NTP (HSCĐ)	*Klebsiella pneumoniae*	4	R	1	S	KPC (–)/NDM1 (–)
63	KN.070	I03.0740	338/0515	Y51	M	Pus	BV. NTP (GMHS)	*Klebsiella pneumoniae*	4	R	4	R	KPC (+)/NDM1 (–)
64	KN.070	I03.0740	338/0515	Y 51	M	Pus	BV. NTP (GMHS)	*Klebsiella pneumoniae*	2	I	1	S	KPC (–)/NDM1 (–)
65	KN.066	I03.0742	354/0515	Y 64	M	LRI (Sputum)	BV. NTP (Nội hô hấp)	*Klebsiella pneumoniae*	4	R	1	S	KPC (–)/NDM1 (–)
66	KN.073	I03.0779	1561/0515	Y78	F	Blood (CVC)	BV. NTP (ĐVLM)	*Klebsiella pneumoniae*	128	R	128	R	KPC (–)/NDM1 (+)
67	KN.074	I03.0815	1338/0615	Y92	F	Urine	BV. NTP (Nội cơ xương khớp)	*Klebsiella pneumoniae*	128	R	128	R	KPC (–)/NDM1 (+)
68	KN.092	I03.0844	543/0715	Y92	F	Urine	BV. NTP (Nội cơ xương khớp)	*Klebsiella pneumoniae*	128	R	64	R	KPC (–)/NDM1 (+)
69	KN.097	I03.0856	1145/0715	Y82	F	LRI (Sputum)	BV. NTP (Ngoại thần kinh)	*Klebsiella pneumoniae*	8	R	16	R	KPC (–)/NDM1 (+)
70	KN.095	I03.0857	1110/0715	Y 96	F	Urine	BV. NTP (HSCĐ)	*Klebsiella pneumoniae*	2	I	1	S	KPC (–)/NDM1 (–)

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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
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 (Nội tổng hợp)	*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 (Nội 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	Y 34	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 (Nội 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	Y 66	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 (Nội 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 (Nội hô hấp)	*Klebsiella pneumoniae*	16	R	8	R	KPC (–)/NDM1 (+)

(Continues)

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
89	KN.160	I03.1307	319/0516	Y89	F	LRI (Sputum)	BV. NTP (Nội hô hấp)	*Klebsiella pneumoniae*	8	R	4	R	KPC (–)/NDM1 (+)
90	KN.159	I03.1324	639-Q2	Y65	F	LRI (Sputum)	BV. Quận 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 (Nội cơ 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 (Nội thận)	*Klebsiella pneumoniae*	> 128	R	64	R	KPC (–)/NDM1 (+)
103	KN.175	I03.1394	1794/0616	Y57	F	LRI (Sputum)	BV. NTP (Nội hô hấp)	*Klebsiella pneumoniae*	2	I	1	S	KPC (–)/NDM1 (–)
104	KN.125	I03.1404	934-Q2		F	Urine	BV. Quận 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)

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
107	KN.167	I03.1440	1269/0716	Y66	F	Urine	BV. NTP (Nội hô hấp)	*Klebsiella pneumoniae*	8	R	16	R	KPC (–)/NDM1 (+)
108	KN.132	I03.1441	1258/0716	Y59	F	Urine	BV. NTP (Nội cơ xương khớp)	*Klebsiella pneumoniae*	32	R	8	R	KPC (–)/NDM1 (+)
109	KN.170	I03.1443	1451/0716	Y82	F	LRI (Sputum)	BV. NTP (Đa khoa)	*Klebsiella pneumoniae*	16	R	16	R	KPC (–)/NDM1 (+)
110	KN.168	I03.1450	1675/0716	Y66	F	LRI (Sputum)	BV. NTP (Nội hô hấp)	*Klebsiella pneumoniae*	16	R	8	R	KPC (–)/NDM1 (+)
111	KN.134	I03.1457	1883/0716	Y63	M	LRI (Sputum)	BV. NTP (Nội hô hấp)	*Klebsiella pneumoniae*	16	R	8	R	KPC (+)/NDM1 (+)
112	KN.134	I03.1457	1883/0716	Y63	M	LRI (Sputum)	BV. NTP (Nội hô hấp)	*Klebsiella pneumoniae*	2	I	1	S	KPC (–)/NDM1 (–)
113	KN.169	I03.1474	861/0816	Y67	F	Blood (CVC)	BV. NTP (HSCĐ)	*Klebsiella pneumoniae*	32	R	8	R	KPC (–)/NDM1 (+)
114	KN.171	I03.1490	1952/0816	Y24	M	LRI (Sputum)	BV. NTP (GMHS)	*Klebsiella pneumoniae*	8	R	8	R	KPC (–)/NDM1 (+)
115	KN.173	I03.1492	091/0916	Y21	F	LRI (Sputum)	BV. NTP (Nội thận)	*Klebsiella pneumoniae*	32	R	8	R	KPC (–)/NDM1 (+)
116	KN.172	I03.1493	059/0916	Y85	M	LRI (Sputum)	BV. NTP (HSCĐ)	*Klebsiella pneumoniae*	16	R	8	R	KPC (–)/NDM1 (+)
117	KN.198	I03.1507	594/0916	Y84	M	LRI (Sputum)	BV. NTP (Nội thần kinh)	*Klebsiella pneumoniae*	16	R	8	R	KPC (+)/NDM1 (+)
118	KN.176	I03.1512	700/0916	Y24	M	LRI (Sputum)	BV. NTP (CTCH)	*Klebsiella pneumoniae*	8	R	16	R	KPC (–)/NDM1 (+)
119	KN.183	I03.1522	929/0916	Y69	F	LRI (Sputum)	BV. NTP (Ngoại thần kinh)	*Klebsiella pneumoniae*	64	R	16	R	KPC (–)/NDM1 (+)
120	KN.180	I03.1523	819/0916	Y85	M	LRI (Sputum)	BV. NTP (HSCĐ)	*Klebsiella pneumoniae*	16	R	8	R	KPC (–)/NDM1 (+)
121	KN.184	I03.1527	1151/0916	Y64	F	LRI (Sputum)	BV. NTP (Nội thần kinh)	*Klebsiella pneumoniae*	2	I	1	S	KPC (–)/NDM1 (–)
122	KN.185	I03.1529	1167/0916	Y81	F	LRI (Sputum)	BV. NTP (HSCĐ)	*Klebsiella pneumoniae*	64	R	16	R	KPC (+)/NDM1 (+)
123	KN.191	I03.1539	1965/0916	Y49	M	LRI (Sputum)	BV. NTP (HSCĐ)	*Klebsiella pneumoniae*	16	R	8	R	KPC (–)/NDM1 (+)
124	KN.204	I03.1552	367A/1016	Y85	M	Pus	BV. NTP (HSCĐ)	*Klebsiella pneumoniae*	16	R	8	R	KPC (–)/NDM1 (+)

(Continues)

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
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. Quận 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. NTP (Đa khoa)	*Klebsiella pneumoniae*	64	R	32	R	KPC (–)/NDM1 (+)
140	KN.249	I03.1678	023DV	Y96	M	LRI (Sputum)	BV. NTP (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 (+)

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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
143	KN.245	I03.1693	1177/0117	Y91	F	LRI (Sputum)	BV. NTP (Nội hô hấp)	*Klebsiella pneumoniae*	16	R	8	R	KPC (–)/NDM1 (+)
144	KN.246	I03.1694	1240/1216	Y79	F	LRI (Sputum)	BV. NTP (Nội hô hấp)	*Klebsiella pneumoniae*	64	R	32	R	KPC (–)/NDM1 (+)
145	KN.247	I03.1699	1517/0117	Y59	M	LRI (Sputum)	BV. NTP (Nội hô hấp)	*Klebsiella pneumoniae*	64	R	8	R	KPC (–)/NDM1 (+)
146	KN.256	I03.1700	003/0217	Y55	M	LRI (Sputum)	BV. NTP (Nội 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 (Nội hô hấp)	*Klebsiella pneumoniae*	128	R	16	R	KPC (–)/NDM1 (+)
149	KN.252	I03.1706	214/0217	Y36	M	LRI (Sputum)	BV. NTP (Nội hô hấp)	*Klebsiella pneumoniae*	128	R	32	R	KPC (–)/NDM1 (+)
150	KN.261	I03.1733	072/0317	Y57	M	LRI (BAL)	BV. NTP (Nội hô hấp)	*Klebsiella pneumoniae*	64	R	8	R	KPC (–)/NDM1 (+)
151	KN.262	I03.1735	059/0317	Y83	M	LRI (Sputum)	BV. NTP (Nội hô hấp)	*Klebsiella pneumoniae*	32	R	8	R	KPC (–)/NDM1 (+)
152	KN.263	I03.1748	473/0317	Y92	M	LRI (Sputum)	BV. NTP (Nội 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 (Nội hô hấp)	*Klebsiella pneumoniae*	> 128	R	128	R	KPC (+)/NDM1 (+)
155	KN.279	I03.1791	073/0417	Y87	M	Blood	BV. NTP (Nội 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 (Nội 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 (Nội hô hấp)	*Klebsiella pneumoniae*	16	R	16	R	KPC (–)/NDM1 (+)

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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
161	KN.292	I03.1831	1235/0517	Y72	F	LRI (Sputum)	BV. NTP (Nội hô hấp)	*Klebsiella pneumoniae*	32	R	8	R	KPC (–)/NDM1 (+)
162	KN.302	I03.1845	1849/0517	Y47	M	LRI (Sputum)	BV. NTP (Nội hô hấp)	*Klebsiella pneumoniae*	32	R	8	R	KPC (–)/NDM1 (+)
163	KN.298	I03.1855	162/0617	Y84	M	Urine	BV. NTP (Nội hô hấp)	*Klebsiella pneumoniae*	> 128	R	128	R	KPC (–)/NDM1 (+)
164	KN.301	I03.1862	300/0617	Y79	F	LRI (Sputum)	BV. NTP (Nội hô hấp)	*Klebsiella pneumoniae*	16	R	8	R	KPC (–)/NDM1 (+)
165	KN.309	I03.1879	1010/0617	Y84	M	Pus	BV. NTP (GMHS)	*Klebsiella pneumoniae*	> 128	R	> 128	R	KPC (–)/NDM1 (+)
166	KN.310	I03.1880	1043/0617	Y71	M	Pus	BV. NTP (LCK)	*Klebsiella pneumoniae*	> 128	R	> 128	R	KPC (–)/NDM1 (+)
167	KN.311	I03.1881	1044/0617	Y75	M	Pus	BV. NTP (Nội hô hấp)	*Klebsiella pneumoniae*	> 128	R	> 128	R	KPC (–)/NDM1 (+)
168	KN.327	I03.1898	1918B/0617	Y81	F	LRI (Sputum)	BV. NTP (Nội tim mạch)	*Klebsiella pneumoniae*	8	R	8	R	KPC (+)/NDM1 (+)
169	KN.328	I03.1900	380DV/17	Y90	F	LRI (Sputum)	BV. Nguyễn Trãi	*Klebsiella pneumoniae*	16	R	4	R	KPC (+)/NDM1 (–)
170	KN.325	I03.1922	178BV7A	Y58	M	Pus	BV 7A	*Klebsiella pneumoniae*	32	R	16	R	KPC (–)/NDM1 (+)
171	KN.332	I03.1924	518A/0717	Y46	M	Blood (CVC)	BV. NTP (HSCĐ)	*Klebsiella pneumoniae*	64	R	16	R	KPC (–)/NDM1 (+)
172	KN.334	I03.1933	916/0717	Y49	F	Pus	BV. NTP (Nội tiết)	*Klebsiella pneumoniae*	16	R	8	R	KPC (–)/NDM1 (+)
173	KN.335	I03.1935	1146/0717	Y80	F	Urine	BV. NTP (Nội tim mạch)	*Klebsiella pneumoniae*	16	R	16	R	KPC (–)/NDM1 (+)
174	KN.337	I03.1941	196BV7A	Y58	M	Pus	BV 7A	*Klebsiella pneumoniae*	32	R	16	R	KPC (–)/NDM1 (+)
175		I03.2783	116/1018	Y48	M	Pus	BV. NTP (GMHS)	*Klebsiella pneumoniae*	0.25	S	0.25	S	KPC (–)/NDM1 (–)
176		I03.2785	179/1018	Y88	F	Pus	Tim mạch can thiệp	*Klebsiella pneumoniae*	1	S	0.25	S	KPC (–)/NDM1 (–)
177		I03.2786	376/1018	Y73	F	Pus	BV. NTP (Nội tiết)	*Klebsiella pneumoniae*	1	S	0.25	S	KPC (–)/NDM1 (–)
178		I03.2787	379/1018	Y62	M	Pus	BV. NTP (Nội tổng hợp)	*Klebsiella pneumoniae*	1	S	0.25	S	KPC (–)/NDM1 (–)

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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
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 (Nội hô hấp)	*Klebsiella pneumoniae*	1	S	0.5	S	KPC (–)/NDM1 (–)
181		I03.2792	506/1018	Y73	F	Pus	BV. NTP (GMHS)	*Klebsiella pneumoniae*	1	S	0.5	S	KPC (–)/NDM1 (–)
182		I03.2793	507/1018	Y73	F	Pus	BV. NTP (GMHS)	*Klebsiella pneumoniae*	0.5	S	0.5	S	KPC (–)/NDM1 (–)
183		I03.2794	413/1018	Y73	F	Blood	BV. NTP (Nội tiết)	*Klebsiella pneumoniae*	0.5	S	0.5	S	KPC (–)/NDM1 (–)
184		I03.2795	414/1018	Y73	F	Blood	BV. NTP (Nội tiết)	*Klebsiella pneumoniae*	0.5	S	0.5	S	KPC (–)/NDM1 (–)
185		I03.2796	432/1018	Y70	F	LRI (Sputum)	BV. NTP (Nội hô hấp)	*Klebsiella pneumoniae*	0.5	S	0.5	S	KPC (–)/NDM1 (–)
186		I03.2797	783/1018	Y64	F	LRI (Sputum)	BV. NTP (Nội cơ xương khớp)	*Klebsiella pneumoniae*	0.5	S	0.25	S	KPC (–)/NDM1 (–)
187		I03.2799	736/1018	Y87	M	LRI (Sputum)	BV. NTP (Nội hô hấp)	*Klebsiella pneumoniae*	1	S	0.25	S	KPC (–)/NDM1 (–)
188		I03.2800	784/1018	Y38	F	Urine	BV. NTP (Nội tim mạch)	*Klebsiella pneumoniae*	1	S	0.25	S	KPC (–)/NDM1 (–)
189		I03.2807	1091/1018	Y77	M	LRI (Sputum)	BV. NTP (Nội hô hấp)	*Klebsiella pneumoniae*	1	S	< 0,25	S	KPC (–)/NDM1 (–)
190		I03.2809	1285/1018	Y65	F	Pus	BV. NTP (Nội 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 (Nội 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 (Nội hô hấp)	*Klebsiella pneumoniae*	4		1	S	KPC (–)/NDM1 (–)
195	KN.047		1922/0814	Y81	F	LRI (Sputum)	BV. NTP (Nội 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 (–)

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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	Y23	M	Pus	BV 7A	*Enterobacter cloacae*	4		1	S	KPC (–)/NDM1 (–)
198	KN.016		499/0214	Y79	M	Urine	BV. NTP (HSCĐ)	*Klebsiella pneumoniae*	8		1	S	KPC (–)/NDM1 (–)
199	KN.041		831DV/0514	Y30	F	Pus	BV 7A	*Klebsiella pneumoniae*	2		1	S	KPC (–)/NDM1 (–)
200	KN.045		927/0814	Y52	M	Pus	BV. NTP (HSCĐ)	*Klebsiella pneumoniae*	4		1	S	KPC (–)/NDM1 (–)