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Michel Djibré, Samuel Fedun, Pierre Le Guen, Sophie Vimont, Mehdi Hafiani, Jean-Pierre Fulgencio, Antoine Parrot, Michel Denis, Muriel Fartoukh

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Michel Djibré M.D [a], Samuel Fedun M.D [a], Pierre Le Guen M.D [a], Sophie Vimont P.D, Ph.D [b,d], Mehdi Hafiani M.D [a,d], Jean-Pierre Fulgencio M.D [a], Antoine Parrot M.D [a], Michel Denis M.D [c], Muriel Fartoukh M.D, Ph.D [a,d]

Author's affiliations:

[a]AP-HP, Hôpital Tenon, Unité de Réanimation et USC médico-chirurgicale, Pôle Thorax Voies aériennes Anesthésie Réanimation, Groupe hospitalier des Hôpitaux Universitaires de l'Est Parisien, Paris, France.

[b]AP-HP, Hôpital Tenon, Service de Bactériologie-Hygiène, Groupe hospitalier des Hôpitaux Universitaires de l'Est Parisien, Paris, France.

[c]AP-HP, Hôpital Tenon, Service de Maladies Infectieuses et Tropicales, Groupe hospitalier des Hôpitaux Universitaires de l'Est Parisien, Paris, France.

[d]Sorbonne Universités, UPMC Univ Paris 06.

Corresponding author:

Michel Djibré, Hôpital Tenon, Assistance Publique - Hôpitaux de Paris, 04 rue de la Chine, 75020 Paris, France

Tel: 33 1 56 01 65 74

Fax: 33 1 56 01 66 49

Email: michel.djibre@tnn.aphp.fr

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Abstract

Background: Although additional contact precautions (ACP) are routinely used to reduce cross-transmission of multidrug-resistant organism (MDRO), the relevance of isolation precautions remains debated. We hypothesized that the collection of recognized risk factors for MDRO carriage on intensive care unit (ICU) admission might be helpful to target ACP without increasing MDRO acquisition during ICU stay, as compared with universal ACP**.**

Materials and Methods: This is a sequential single-center observational study performed in consecutive patients admitted to a French medical and surgical ICU. During the first 6-month period, screening for MDRO carriage and ACP were performed in all patients. During the second 6-month period, screening was maintained, but ACP was guided by the presence of at least one defined risk factor (RF) for MDRO.

Results: During both periods, 33 (10%) and 30 (10%) among 327 and 297 admissions were respectively associated with a positive admission MDRO carriage. During both periods, a second screening was performed in 147 (45%) and 127 (43%) patients. Altogether, the rate of acquired MDRO (positive screening or clinical specimen) was similar during both periods (respectively, 10%, n=15 and 11.8%, n=15; p=0.66).

Conclusions: The results of our study contribute to support the safety of an isolation-targeted screening policy on ICU admission as compared with universal screening and isolation regarding the rate of ICU-acquired MDRO colonization or infection.

Word count: 218

Keywords: multidrug-resistant organism (MDRO); screening; isolation; additional contact precautions; acquisition; infection

BACKGROUND

During the past decade, the prevalence of multi-drug resistant organism (MDRO) has dramatically increased in Europe and worldwide, both in the hospital and the community. This increase is mainly due to the dissemination of extended spectrum beta-lactamase producing enterobacteriaceae (ESBLE), and to a lesser extent to the emerging Extensively Drug Resistant organisms (XDR) such as Glycopetid Resistant *Enterococcus* sp (GRE) and Carbapenem-Resistant Enterobacteriaceae (CRE) (ECDE. Antimicrobial-resistance-surveillance-Europe-2012) [1,2]. Moreover, MDRO colonization is a recognized risk factor for developing MDRO infection [3,4]. Infections caused by MDRO are reputed to be associated with a poor prognosis, with a greater rate of antimicrobial therapy failures [5,6], a more prolonged hospital length of stay and a higher mortality rate [7,8]. The recommendations for the prevention of "cross-transmission" of the French Society of Hospital Hygiene in 2009 do not advocate a routine screening policy for MDRO, either on ICU admission or during ICU stay, except during outbreaks. The Center for Disease Control and Prevention (CDC) International recommendations [9] endorse additional contact precautions [ACP] (wearing gown and gloves) in case of MDRO colonization or infection. However, those recommendations may not be implemented in a timely fashion to minimize cross transmission, if MDRO carriage is not routinely screened for. Although ACP are routinely used to control the spread of MDRO, the relevance of isolation precautions remains debated [10,11], resulting in a great heterogeneity of practices in the ICUs [12]. Many uncontrolled series have provided mixed results rather favoring ACP effectiveness [13–16]. Two recent cluster randomized controlled trials conducted in medical and surgical ICUs [Harris et al.[17] and Huskins et al.[18]] did not find significant differences between universal preemptive ACP and standard precautions, alone or with universal gloving, in the acquisition of MRSA or GRE. The

difficulty in analyzing the effectiveness of ACP is due to the multi modal nature of the measures used to limit MDRO spread [19]: hand hygiene compliance [20], surfaces cleaning [21], presence of individual lavatories [22], use of single rooms, type of unit (ICU or other unit), etc. The use of ACP is typically associated with psychological, financial drawbacks, and possibly lower quality of care although these data have been recently questioned [23,24]. Additional costs may be observed when human resources or materials are required [25].

Risk factors (RF) for MDRO carriage or infection (especially ESBLE) have been described [26–28], but a performant "clinical tool" to guide isolation is still lacking, resulting in a delayed implementation of ACP of 24 to 96 hours according to the techniques used [29,30].

We hypothesized that the collection of recognized risk factors for MDRO carriage on ICU admission might be helpful to target ACP without increasing MDRO acquisition during ICU stay, as compared with universal ACP.

MATERIALS AND METHODS

Ethics

This study was approved by all participating wards. No ethical approval was necessary for this observational study including routine care and according to the French law.

Study design

We conducted a sequential study during two consecutive six-month periods in a 20-bed medical and surgical ICU of a French university-affiliated hospital. Our ICU has only single rooms, and individual washing basins. Gloves, gowns, sinks and bins are available inside the rooms, alcohol-based handrub solution are available inside and outside each room and on the entire unit (hallways, medical offices, nurse monitoring stations, maintenance room, etc. ...).

During the first period running from June to November 2012, rectal swabs were routinely obtained on admission, and were associated with preemptive ACP pending the results of cultures which were obtained 48 to 72 hours thereafter. PCR methods were not used in our hospital.

During the second period (February to August 2013), all consecutively admitted patients were systematically screened on admission with a rectal swab, but preemptive ACP were implemented only for patients having at least one RF for MDRO carriage. A priori defined selected RF were collected from the patient or his/her relatives and from the medical records: exposure to antibiotics within the preceding 3 months, hospitalization within the preceding year, admission of another hospital department with a hospital stay of more than 5 days, immunosuppression (defined by the existence of HIV disease, active cancer, immunosuppressive therapy), chronic dialysis, transfer from rehabilitation, long term care unit or nursing home, and travel abroad within 1 year. A risk index (RI) was calculated by the sum of RFs. When RI was equal or greater than 1, preemptive isolation with ACP was associated with standard precautions (SP). Otherwise, SP alone were performed.

During both periods, a rectal swab was performed on admission, searching for ESBLE or carbapenem-resistant Enterobacteriaceae (CRE) carriage. Due to a very low infection rate with MRSA or GRE in our ICU, corresponding screening was guided by the presence of individual RFs.

The standard precautions included hand hygiene, protective gowns and gloves in case of risk of contact with blood or body fluids, and gloves in case of lesions of the health care worker's hands. The ACP included hand hygiene at room entrance and exit, wearing gowns during contact with patient and bodily fluids, wearing gloves as part of SP, door signs at the rooms' entrance stating "isolation screening" or "isolation confirmed". Oral information was given

to the patients and relatives. The ACP were maintained in case of screening or clinical sample for MDRO, on admission or during hospitalization. A weekly screening MDRO by rectal swab was performed.

Eligibility

Patients who did not have MDRO screening on admission, and patients who were already known carriers, either infected or colonized with MDRO, were not included.

Measurements

Demographic and clinical characteristics were collected during both periods, including age, sex, comorbidities, main reason for ICU admission, SAPS2 score, ICU length of stay and mortality.

Bacteriological samples, screening and clinical specimens included: date of collection, MDRO culture results, bacterial species identification and resistance type. A positive screening or clinical specimen for MDRO was considered imported, when the sample was taken before the first 72 hours of ICU admission; otherwise, it was acquired.

All swabs and clinical samples were analyzed at the Tenon Hospital Microbiology Laboratory, according to a standardized protocol following the recommendations of the French National Society for Microbiology (European Manual of Clinical Microbiology 2012). The results were available on the hospital intranet and communicated by phone within 48 hours. There was neither intervention between the two periods to improve hand hygiene compliance, nor changes in barrier precaution procedures or in hospital or ICU antibiotic stewardship programs.

Statistical analysis

The primary outcome was the rate of MDRO acquisition during ICU stay. Results are reported as median and inter-quartile range (25-75) and numbers (n) and percentages (%) for quantitative and qualitative variables, respectively, unless otherwise stated. Demographics and clinical data were analyzed using the chi-square test or the Fisher's exact test for categorical data, and the nonparametric Mann Whitney *U* test for continuous variables.

Crude associations between each potential predictor and MDRO carriage were quantified by the odds ratio (OR) and the corresponding 95% confidence intervals (CI). Predictors analyzed included the baseline characteristics and the clinical characteristics and laboratory values on ICU admission. The variables stratified in several classes were dichotomized into binary variables, according to their distribution in univariate analysis and their clinical relevance. *P* values <0.05 were considered statistically significant. Independent predictors of MDRO carriage were then determined using multivariate logistic regression models. The number of events per variable entered in the final multivariate model averaged a ratio of 1 per 10 to avoid over fitting. Variables entered in the multivariate model were associated with a p-value ≤0.20 in the univariate analysis. A goodness-of-fit test (Hosmer-Lemeshow) and the area under the receiver operating characteristic (ROC) curve were performed to assess calibration and discrimination of the model. For isolation strategies based on the presence of one or more RFs, sensitivity, specificity, negative predictive value (NPV) and positive predictive value (PPV) were calculated. The Stata software (StataCorp, College Station, Texas, USA) was used for analysis.

RESULTS

Study population

During the first period, 403 consecutive patients were admitted to the ICU totaling 413 admissions, of which 86 (20%) had non-inclusion criteria (Figure 1a). During the second period, there were 368 admissions in 360 patients, of which 71 (19%) had non-inclusion criteria (Figure 1b). Altogether, 327 and 297 admissions were analyzed in 763 patients during both periods, with a stable rate of compliance to admission screening.

Patient characteristics at ICU admission

The general characteristics of the admissions were similar during both periods (Table 1). The main reasons for ICU admission were respiratory failure in half of the cases, severe sepsis or septic shock, neurological failure, circulatory failure, and postoperative monitoring. The median SAPS II was 32 [22-46] and 32 [20-48] during both periods, with corresponding ICU length of stay and mortality rate of 5 [3-9] and 5 [3-8] days, and 10% and 12%, respectively.

Risk factors for MDRO carriage were prospectively collected among the 297 admissions of the second period, and their distribution is shown Table 2a. The most common RFs were administration of antibiotics within the preceding 3 months (n=139; 47%) and hospitalization within the preceding year (n=175; 59%). A risk index (RI) could be calculated in 97% of the cases (n=288), averaging a median value of 2 points [1-3].

Effect of targeted ACP on MDRO acquisition during ICU stay

A second MDRO screening was performed in 147 (45%) and 127 (43%) admissions during the systematic (period 1) and targeted (period 2) isolation periods (Table 1, figures 1a and 1b). Altogether, the rate of acquired MDRO (positive screening or clinical specimen) was similar during both periods (respectively, 10%, n=15 and 11.8%, n=15; p=0.66). Among MDRO negative patients on ICU admission, the rate of acquired MDRO was 8.4% (n=11) and 13%

(n=15) (p=0.24), respectively. Of those latter, 9 and 4 had at least one positive MDRO clinical sample, respectively.

Multidrug-resistant organism

There were 33 (period 1) and 30 (period 2) patients with a positive MDRO screening on admission (p=0.9) (Table 1). Among those imported cases, 9 (2.7%) in period 1, and 13 (4%) in period 2 (p=0.11) had at least one positive MDRO clinical sample within the first 72 hours. During both periods, the main imported MDROs were ESBLEs (*E. coli*, n=36; *K. pneumoniae*, n=9; *Enterobacter sp*, n=8). The main acquired MDROs were also ESBLEs (*E. coli*, n=10; *K. pneumoniae*, n=5; *Enterobacter sp*, n=7). Noteworthy, there were 6 imported and 2 acquired MRSA strains.

Variables associated with admission MDRO carriage

In univariate analysis (period 2), the median risk score was 3 [2-4] for MDRO carriers, as compared with 2 [1-3] in non-MDRO carriers (p <0.01). A prior hospital stay of more than 5 days (p=0.008) and chronic dialysis (p=0.04) were associated with a MDRO carriage on ICU admission. In multivariate analysis, a prior hospital stay of more than 5 days (OR 2.38, 95% CI 1.04 to 5.46; p=0.04) remained independently associated with a MDRO carriage on ICU admission (Tables 2a and 3).

Among patients with no RF identified on ICU admission (RI=0; n=56, 19%), only 1 was carrying a MDRO (*E. coli* ESBL). Thus, the negative predictive value of a risk index of zero was higher than 98%, with a sensitivity of 96%. However, a RI ≥ 1 had very low positive predictive value and specificity. When the RI threshold was increased to 2 or 3, the specificity increased (37% and 65%, respectively) at the expense of a large sensitivity decrease (82% and 55%, respectively).

Variables associated with ICU-acquired MDRO

In univariate analysis (period 2), ICU length of stay (p=0.001) and immunosuppression (p=0.01) were associated with ICU-acquired MDRO (Table 2b).

DISCUSSION

The aim of this single center pilot study was to address the hypothesis that there would be no MDRO acquisition increase during ICU stay, using selected MDRO risk factors for guiding targeted isolation, *i.e.* using selective use of ACP to SP, on patients admitted to the ICU, as compared with universal ACP. We found similar rates of MDRO acquisition, mainly ESBLEs, between the two strategies. In addition, the risk estimate of MDRO carriage using selected risk factors was feasible, and a zero risk estimate had a very good negative predictive value, allowing a 19% reduction rate of the use of ACP. A prior hospitalization for more than five days was the only factor associated with a MDRO carriage on ICU admission.

A recent observational study conducted in two ICUs has investigated the safety of a targeted screening for third-generation cephalosporin-resistant *Enterobacteriaceae* (3GC-RE) on ICU admission on the incidence of 3GC-RE hospital acquired infections (HAIs), as compared with universal screening[31]. The intervention was the implementation of targeted screening only for patients transferred from another unit to one of the ICUs. A targeted screening was not associated with an increase in 3GC-RE hospital-acquired infections, as compared with universal screening, despite fewer ACP. Another observational restrospective study compared the incidence of EBLSE between two French university hospitals : one hospital only implemented SP after identification of patients colonized with EBLSE, while the other recommended ACP[32]. In the same way, this study did not reveal a benefit of ACP on clinical samples positive for EBLSE. *Ledoux et al.* investigated the impact of a targeted isolation strategy on ICU admission in a prospective uncontrolled before-after study conducted in a

mixed ICU during two 12-month periods[33]. The targeted isolation was not inferior to the systematic isolation, regarding the rate of ICU-acquired MDRO infections. Thus, the results of our study may contribute to support the safety of targeted preemptive isolation precautions on ICU-acquired MDRO (mainly ESBLE) colonization or infection.

Even so a targeted strategy seems safe in MDRO infection control, the choice of RFs may influence the accuracy of such a strategy and the rate of unnecessary ACP avoided. The RFs most consistently associated with MDRO carriage or infection include a recent hospitalization, admission from a healthcare facility, numerous comorbidities, a recent use of antibiotics including beta-lactams and quinolones, age > 70 years, immunosuppression, chronic dialysis, recent surgery, recent urinary catheterization, history of MDRO colonization and a trip abroad[1,26–28,34,35].

Of note, many of these RFs are common to different MDROs, including MRSA and ESBLE. In our series, the choice of the seven RFs was performed through a consensus of the physicians of the unit, based on recognized clinical factors and simplicity for prospective collection. The prevalence of some factors was high, especially antibiotics exposure within the preceding 3 months, hospitalization within the preceding year, hospitalization of more than 5 days, immunosuppression and trip abroad, as reported in other European series conducted in the ICU[26,34]. Based on the American Thoracic Society (ATS)/Infectious Diseases Society of America (IDSA) criteria in predicting MDRO colonization or infection on ICU admission, *Ledoux et al*. were able to avoid up to 36% of unnecessary isolation among patients with no RF identified, as compared with 19% in our study. However, the presence of at least one RF was poorly predictive of MDRO carriage on ICU admission, with a low specificity of 37% and a low positive predictive value of 20%.

Only few series have attempted to develop tools to help for identifying MDRO colonization

or infection on hospital admission[36,37]. Such a tool might be useful to implement additional hygiene measures quickly, minimize cross transmission, help to target patients eligible for screening and guide empirical antibiotic therapy for the highest risk patients. Even if “Italian model”[36] and “Duke model”[37] revealed excellent discrimination (area under the ROC curve 0.89), the RFs and thresholds retained were quite different from a model to another. These findings underscore the difficulty in establishing a "universal" risk score for MDRO, because the conditions of application depend on geographic location, populations, health care ressources, type and prevalence of bacterial species. Determining the optimal RFs which should be chosen is also complex, according to the expected purpose of the tool, *i.e.* to target the patients at risk of carriage for infection control purposes and/or to guide the empirical antimicrobial treatment.

The prevalence of ESBLE carriage among patients admitted to the ICU may range from 3% to 49%[38–41]. In a French study conducted in a medical ICU, rectal carriage of ESBLE was 15% on admission, and the acquisition rate was 13% [26]. In our study, the MDRO importation rate, colonization or infection (84% of ESBLE) was 10% during the two periods, and the acquisition rate of 11%, particulary in case of prolonged ICU length of stay and in immunocompromised patients.

Thus, excluding epidemic situation in a 20-bed medical-surgical ICU with a standard compliance rate of standard precautions and MDRO imported rate (ESBLE mainly) of middle level, a more restrictive strategy for preemptive isolation on ICU admission, guided by the existence of carrying RF, is not accompanied by an increase in the rate of MDRO acquired during ICU stay. It is possible that this strategy could be appropriate in some ICU settings when coupled with good antimicrobial stewardship and infection prevention compliance, and it would allow for consumption of fewer resources.

Our study has several limitations. The compliance to hand hygiene and contact precautions have not been measured, and therefore undetected changes in practice especially with regard to hand hygiene could have modified the MDRO acquisition rate between the two periods. This hypothesis is unlikely, however, given the stability of consumption in alcohol-based handrub solution, and the absence of significant turnover of nursing staff between the two periods. The antibiotic policy has not changed and overall antibiotic consumption evaluated with defined daily doses was stable between the two periods, however, a change in the nature of antibiotics delivered and therefore the selection pressure can not be completely eliminated.

Acquisition rates could be estimated in only a fraction of the population due the relatively short median stay and lack of follow-up or discharge sample in about 50% of the population, thus possibly missing some acquisition; however a similar proportion of patients were not screened in both periods. In our study, no molecular typing of MDRO isolates was performed, so we cannot asses if MDRO strains acquired during the ICU stay resulted of cross-transmition or *in vivo* selection. The limited number of patients with MDRO hampers the analysis of RFs for MDRO carriage on ICU admission resulting in poor identification of MDRO carriers. The impact of the reduction of the isolations on cost, quality of care, workload, adverse events and patient satisfaction and staff has not been evaluated. The conclusions of our work pertains essentially to ESBLE, which represented the majority of bacterial species found, and may not be extrapolated to other MDRO, such as MRSA and GRE which were not screened systematically. Moreover, these results are not transferable in ICU with different local conditions, particularly in terms of bacterial ecology or hygiene.

CONCLUSION

An isolation-targeted screening policy from the estimate of the risk of carrying a MDRO on admission is easily achievable and non-inferior to universal screening and isolation. Such a strategy could be used with no increase of MDRO colonization or infection. However, among the risk factors for MDRO carriage tested in our study, only transfer after hospitalization of 5 days or more discriminates carriers from non-carriers, with a poor positive predictive value. Further searches on risk factors for MDRO carriage are needed to improve targeted screening and/or isolation on ICU admission.

Conflict of interest The authors declare that they have no conflict of interest.

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Table 1. Characteristics of the patients during both periods

	Period 1	Period 2	P value
Admissions, n	413	368	
Patients screened, n (%)	327 (79)	297 (81)	0.59
Age (years), median [IQR]	62 [45-70]	59 [42-69]	0.12
Sex ratio (M:F), n	256 / 157	230 / 138	0.88
Reasons for ICU admission, n (%)			
Acute respiratory failure	174 (53)	137 (46)	
Severe sepsis/septic shock	56 (17)	44 (15)	
Postoperative monitoring	19 (6)	34 (11)	1
Neurologic failure	15 (4.5)	28 (9)	
Circulatory failure	34 (10)	33 (11)	
Others	29 (9)	21 (7)	
SAPS II, median [IQR]	32 [22-46]	32 [20-48]	0.58
ICU length of stay (days), median [IQR]	5 [3-9]	5 [3-8]	0.32
ICU mortality, n (%)	40 (10)	45 (12)	0.28
MDRO carriage on ICU admission, n (%)	33 (10)	30 (10)	0.9
Second screening in non MDRO carriers on admission, n (%)	130 (44)	115 (43)	0.79
ICU-acquired MDRO, n (%)	11 (8.4)	15 (13)	0.24
Second screening in MDRO carriers on admission, n (%)	17 (51)	12 (40)	0.45
ICU-acquired MDRO, n (%)	4 (23)	0 (0)	0.12

Period 1: systematic screening and isolation. Period 2: systematic screening and targeted isolation.

Quantitative variables are expressed as median and interquartile range [IQR 25-75]. Qualitative variables are described as numbers (n) and percentages (%).

Abbreviations: MDRO multi drug resistant organism; ICU intensive care unit.

Table 2a. Variables associated with admission MDRO carriage (period 2, systematic screening and targeted isolation)

	MDRO - (n=267)	MDRO + (n=30)	P value
Age (year), median [IQR]	59 [42-70]	60 (48-73]	0.27
Sexe ratio: M / F, n	126 / 141	12 / 18	0.45
Medical / Surgical admission, n	191 / 76	24 / 6	0.32
SAPS II, median [IQR]	32 [20-47)	40 [24-50]	0.4
ICU length of stay (days), median [IQR]	5 [3-11)	5 [4-8]	0.07
Risk index, median (IQR]	2 [1-3]	3 [2-4]	<0.01
ICU mortality, n (%)	26 (10)	3 (10)	0.96
Antibiotics within 3 months, n (%)	120 (45)	19 (63)	0.07
Prior hospitalization in the year, n (%)	153 (57)	22 (73)	0.11
Prior hospital stay > 5 days, n (%)	70 (26)	15 (50)	0.008
Immunosuppression, n (%)	83 (31)	10 (33)	0.81
Chronic hemodialysis, n (%)	11 (4)	4 (13)	0.04
Transfert from nursing home or longterm facility, n (%)	7 (3)	1 (3)	0.83
Travel abroad < 1 year, n (%)	58 (22)	7 (23)	0.89

Quantitative variables are expressed as median and interquartile range [IQR 25-75].
Qualitative variables are described as numbers (n) and percentages (%).
Abbreviations: MDRO multi drug resistant organism; ICU intensive care unit.

Table 2b. Variables associated with ICU-acquired MDRO (period 2, systematic screening and targeted isolation)

	MDRO2 - (n=100)	MDRO2 + (n=15)	P value
Age (year), median [IQR]	60 [40-69]	55 [47-66]	0.67
Sexe ratio: M / F, n	48/52	10/5	0.14
Medical / Surgical admission, n	69/31	7/8	0.09
SAPS II, median [IQR]	40 [25-54]	43 [28-57]	0.55
ICU length of stay (days), median [IQR]	10 [5-18]	19 [15-25]	0.001
Risk index, median [IQR]	2 [1-3]	2 [2-3]	0.36
ICU mortality, n (%)	11 (11)	1 (6)	1
Antibiotics within 3 months, n (%)	47 (47)	7 (58)	0.5
Prior hospitalization in the year, n (%)	60 (60)	8 (61)	0.9
Prior hospital stay > 5 days, n (%)	23 (23)	5 (38)	0.45
Immunosuppression, n (%)	31 (31)	9 (69)	0.01
Chronic hemodialysis, n (%)	5 (5)	1 (7)	0.52
Transfert from nursing home or longterm facility, n (%)	3 (3)	0	1
Travel abroad < 1 year, n (%)	23 (23)	3 (20)	1

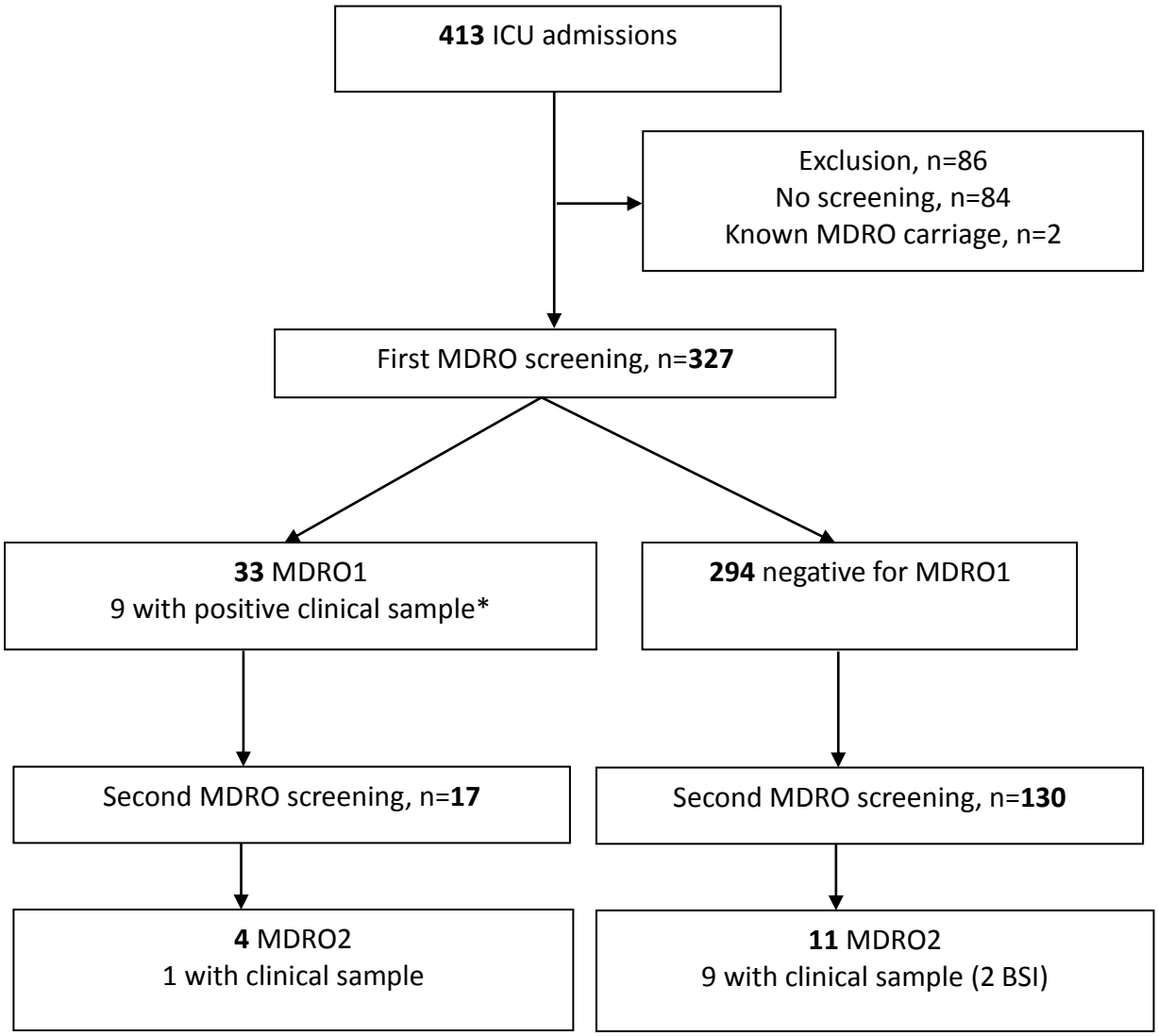
Quantitative variables are expressed as median and interquartile range [IQR 25-75].
Qualitative variables are described as numbers (n) and percentages (%).
Abbreviations: MDRO multi drug resistant organism; MDRO2 ICU-acquired multi drug resistant organism; ICU intensive care unit.

Table 3. Multivariate analysis of variables associated with admission MDRO carriage (period 2, systematic screening and targeted isolation)

Positive admission MDRO screening or clinical sample	Univariate analysis		Multivariate analysis	
	Odds Ratio (95% CI)	P	Odds Ratio (95% CI)	P
Antibiotics within the preceding 3 months	2.15 (0.93-4.93)	0.07	1.64 (0.68-3.94)	0.27
Chronic dialysis	3.58 (1.06-12.07)	0.04	2.16 (0.53-8.69)	0.28
Prior hospital stay > 5 days	2.88 (1.32-6.27)	0.008	2.38 (1.04-5.46)	0.04
Sensitivity (%)				52%
Specificity (%)				73%
Positive predictive value (%)				18%
Negative predictive value (%)				93%
Likelihood ratio positive/negative				1.90/0.66

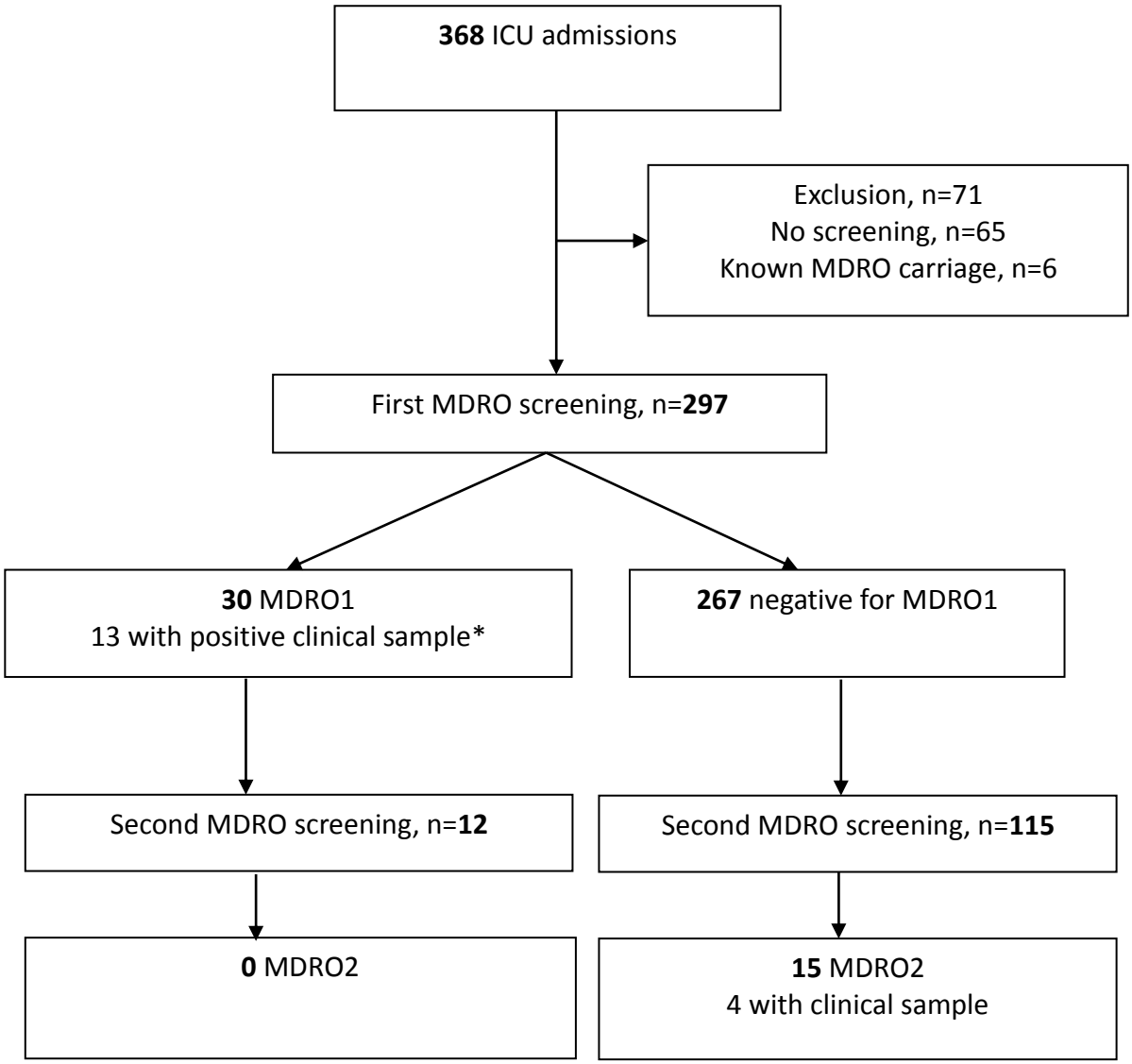
Abbreviations: MDRO multi drug resistant organism.

Figure 1a. Patients' selection during the first period (systematic screening and isolation)



Abbreviations: MDRO1 multi drug resistant organism on ICU admission; MDRO2 ICU-acquired multi drug resistant organism; BSI bloodstream infection.
* including 2 bloodstream infection.

Figure 1b. Patients' selection during the second period, (systematic screening and targeted isolation)



Abbreviations: MDRO1 multi drug resistant organism on ICU admission; MDRO2 ICU-acquired multi drug resistant organism; BSI bloodstream infection.
* including 2 blood stream infection.