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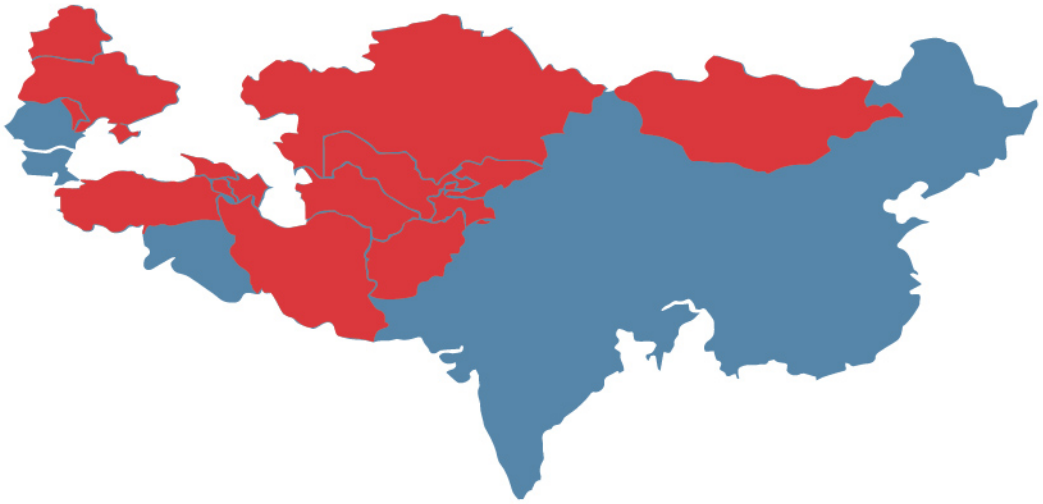
Learning from Practice: Public Health Teaching Case Studies from Eastern Europe and Central Asia



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Multidrug-resistant *Klebsiella Pneumoniae* outbreak in Sahloul University Hospital in Tunisia, July-August 2022

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Abstract

Background: On July 27th and 29th, 2022, the Prevention and Safety of Care Department at Sahloul University Hospital was alerted to an outbreak of invasive infections caused by carbapenem-resistant *Klebsiella pneumoniae* (CRKP). The infections were reported in three departments: Post Serious Operations (PSO), Surgical Resuscitation, and Orthopedics. This case study examines the outbreak, focusing on the epidemiological investigation, environmental survey, and the audit of infection control practices.

Teaching Methods: The teaching approach involves a systematic methodology for conducting outbreak investigations and implementing infection control strategies in a university hospital. Students will describe cases by time, person, and place, and prepare synoptic charts. They will also evaluate adherence to standard hygiene precautions and interpret data from figures and tables, leading to recommendations for corrective actions.

Results: This epidemic involved three cases of patients with intrinsic (comorbidities) and extrinsic (invasive procedures: gastrostomy, vascular catheterization, urinary catheter) risk factors. The three isolated strains had the same antibiotype characterized by resistance to all antibiotics except Fosfomycin and colistin. The environmental survey didn't monitor any Klebsiella pneumoniae in the three patients' environments. From the six criteria of the standard hygiene precautions, 16 observations were tested in the audit, from which (10; 62.5%) were respected in the Surgical Resuscitation department, (8; 50%) in the PSO department and (2; 12.5%) in orthopedic department.

Conclusion: This investigation highlights the need for a proactive surveillance system and strict adherence to infection control measures to prevent the spread of CRKP.

- **Keywords:** *Klebsiella pneumoniae,* Outbreaks, Hospitals.

How to Use the Case Study

General instructions: This case study should be used as adjunct training material for novice epidemiology trainees to reinforce the concepts taught in prior lectures. The case study is ideally taught by a facilitator in groups of about 20 participants. Participants are to take turns reading the case study, usually a paragraph per student. The facilitator guides the discussion on possible responses to questions. The facilitator may make use of flip charts to illustrate certain points. Additional instructor's notes for facilitation are coupled with each question in the instructor's guide to aid facilitation.

Audience: This case study was developed for novice field epidemiology students. These participants are commonly health care workers working in the county departments of health whose background may be as medical doctors, nurses, environmental health officers or laboratory scientists who work in public health-related fields. Most have a health science or biology background.

Prerequisites: Before using this case study, participants should have received lectures on disease surveillance and outbreak investigation.

Materials needed: Flash drive, flip charts, markers, computers with MS Excel

Level of training and associated public health activity: Novice – **Outbreak investigation.**

Time required: 2-3 hours.

Language: English

Goal of the Case Study:

To build capacities of investigating and controlling an outbreak of carbapenem-resistant Klebsiella pneumoniae infections at a University Hospital.

Learning Objectives – At the conclusion of the teaching session, participants will be able to:

1. Outline the preparations required prior to conducting a field investigation.
2. Describe the cases according to time, person, and place, and develop a synoptic chart.
3. Assess adherence to standard hygiene precautions in the affected departments.
4. Analyze and interpret the data presented in figures and tables.
5. Recommend infection control measures to prevent the spread of carbapenem-resistant *Klebsiella pneumoniae*.

Background

Despite strict decisions and adopting strict infection prevention and control measures, many outbreaks of Multi Drug-Resistant Organisms (MDRO) have been reported during and after the COVID-19 pandemic [1,2]. These organisms pose an ever-increasing threat on health-care systems around the world [3]. Tunisia is a developing country in north Africa which, despite the various surveillance and intervention systems, still didn't control healthcare-Associated Infections [4].

In some Tunisian institutions like Sahloul University Hospital in Sousse, these types of infections in humans are mandatory notifiable by laboratories [5]. Sahloul university hospital is one of the biggest hospitals in Tunisia, located in Sousse and hosts a wide array of activities and services. It is a 690-bed tertiary care center. Containing multiple surgical blocks and other specialized units in intensive care and emergency, it plays a pivotal role in catering to a diverse range of healthcare needs. The presence of various patient populations with varying degrees of medical vulnerability, coupled with the constant influx of visitors and medical personnel, further contributes to the heightened risk. However, the multifaceted nature of its operations and the various medical disciplines create a vulnerable environment to nosocomial infections[6]. Despite rigorous protocols and diligent efforts to maintain hygiene and infection control, the complexity of the hospital's operations poses a challenge in mitigating the occurrence of these infections. Therefore, the hospital needs a continuous and vigilant approach to surveillance, prevention, and containment.

Epidemiological surveillance of healthcare-associated infections (HAIs) is crucial for patient safety and efficient healthcare management. By collecting and analyzing data on HAI occurrence and trends, healthcare facilities can swiftly detect outbreaks, identify risk factors, and evaluate the effectiveness of infection control measures. This proactive approach not only minimizes the impact of HAIs on patients and healthcare workers but also supports transparency, antibiotic stewardship, and the containment of MDRO.

One of the common resistant organisms detected in Sahloul University Hospital is *Klebsiella pneumoniae* which is a saprophytic and commensal enterobacteria, isolated from the environment

and from the fecal flora of humans and animals. It is responsible for urinary infections, respiratory infections, and bacteremia. It is also commonly found in water, soil, and dust. *Klebsiella pneumoniae* is a privileged host for certain plasmids causing multidrug resistance.

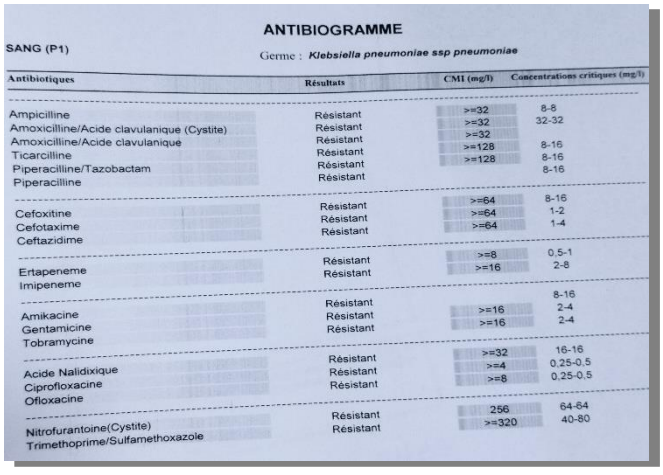
This case study examines the outbreak, focusing on the epidemiological investigation, environmental survey, and the audit of infection control practices.

Part 1 Story (Narrative)

On the morning of July 27th, 2022, a tense atmosphere filled the Prevention and Safety of Care Department at Sahloul University Hospital. Medical residents gathered for their routine briefing. Dr. X the dedicated assistant responsible for monitoring and reporting outbreaks, entered the room with a solemn expression. Her demeanor sent a wave of apprehension through the room.

When Dr. X spoke, her words confirmed the worst. The microbiology laboratory had just identified a critical situation : three patients, all from different departments—Post Serious Operations, Surgical Resuscitation, and Orthopedics—had developed invasive infections. These were not ordinary infections but were caused by multi-resistant Klebsiella pneumoniae. The realization that the cases were spread across crucial areas of the hospital hit like a shockwave.

The weight of the situation was undeniable, but there was no time for hesitation—everyone understood that swift, coordinated efforts were crucial to halt the spread and protect other patients.



ANTIBIOGRAMME

SANG (P1)

Germe : *Klebsiella pneumoniae ssp pneumoniae*

Antibiotiques	Résultats	CMI (mg/l)	Concentrations critiques (mg/l)
Ampicilline	Résistant	>=32	8-8
Amoxicilline/Acide clavulanique (Cystite)	Résistant	>=32	32-32
Amoxicilline/Acide clavulanique	Résistant	>=32	
Ticarcilline	Résistant	>=128	8-16
Piperacilline/Tazobactam	Résistant	>=128	8-16
Piperacilline	Résistant		8-16
Cefoxitine	Résistant	>=64	8-16
Cefotaxime	Résistant	>=64	1-2
Ceftazidime	Résistant	>=64	1-4
Ertapeneme	Résistant	>=8	0.5-1
Imipeneme	Résistant	>=16	2-8
Amikacine	Résistant		8-16
Gentamicine	Résistant	>=16	2-4
Tobramycine	Résistant	>=16	2-4
Acide Nalidixique	Résistant	>=32	16-16
Ciprofloxacine	Résistant	>=4	0.25-0.5
Ofloxacine	Résistant	>=8	0.25-0.5
Nitrofurantoine(Cystite)	Résistant	256	64-64
Trimethoprime/Sulfamethoxazole	Résistant	>=320	40-80

Part 1 questions

Question 1: Is this an epidemic?

Question 2: Should the hospital react to this alert and why? **Justify your answer.**

Question 3: What are the possible sources of carbapenem-resistant *Klebsiella pneumoniae* within the hospital departments?

Part 2 Methods (NARRITIVE)

Case definition: A case was defined as any patient with carbapenem drug-resistant Klebsiella pneumoniae healthcare associated infection that was diagnosed from July 27th to August 12th, 2022, identified using antibiogram in Sahloul university hospital. The identification was conducted mainly based on laboratory data and a review of medical records.

Data analysis: Data collected concerning confirmed cases was summarized specifying the department, admission date and its reason, invasive act(s), confirmation date, site of infection, antibiotics prescribed, and evolution. All patients whose management involved the sharing of paramedical and/or medical caregivers were considered as: "contact case *Klebsiella pneumoniae*". The geographical description of the epidemic was conducted based on the architecture of the hospital. The description of time was schematized on a synoptic table produced on Microsoft Excel.

Environmental survey: Samples from the healthcare environment in which the infected patients were hospitalized were taken using swabs. The samples were kept in a cooler, labeled, and sent to the regional laboratory of Environmental Hygiene of the Regional Health Directorate of Sousse. The samples were taken in the A3 surgical resuscitation room, the O2 operating room (common room between the orthopedic department and the neurosurgery department), in the orthopedic isolation room and in the hands of medical and paramedical personnel. The sites sampled were scope column, patient's bed, work bench, room door, syringe pump and sink siphon. Early corrective measures were implemented in the PSO department's infected room after the death of the patient, as the environment was totally disinfected 3 times. That resulted in the non-collection of environmental samples.

Audit of good care practices: An audit was carried out by observing the standard hygiene precautions in the three departments concerned assessing the following criteria: hand hygiene, equipment and personal protection, treatment trolley, antiseptics, nursing, and the general hygiene.

Ethical consideration: During this outbreak investigation, patient confidentiality were respected. All patient information was anonymized, and consent was obtained for the use of clinical data. The focus remained on patient safety and protecting healthcare workers, with an emphasis on fostering improvement rather than blame. Ethical principles guided every step to ensure the dignity and rights of all involved were respected.

Questions

Question 4: What preparations are necessary before conducting a field investigation?

Question 5: What is the difference between acquired cases and imported cases?

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Question 6: What crucial information should be collected during data collection?

Question 7: What role do you think the laboratory plays in this scenario?

Part 3: Results (Narrative, figures, tables)

Hospitalization characteristics of the three cases of carbapenem-resistant *Klebsiella pneumoniae* at Sahloul University Hospital are summarized in Table 1.

All *Klebsiella pneumoniae* strains isolated were resistant to all tested antibiotics, including beta-lactams, aminoglycosides, fluoroquinolones, and cotrimoxazole.

The first case, reported in the Surgical Resuscitation Department on July 24th, 2022, involved a 60-year-old female patient. She had been hospitalized on July 2nd, 2022, following complications from

cholecystitis surgery performed in June. The patient, quadriplegic and bedridden, was receiving parenteral nutrition. A urinary catheter was placed on July 7th, along with a central catheter that remained from July 7th to July 27th. On July 15th, a gastrostomy was performed, and a swab of the site on July 24th tested positive for carbapenem-resistant *Klebsiella pneumoniae* on July 27th.

The second case was identified in the Post Serious Operations (PSO) Department on July 24th, 2022. This involved a 65-year-old male patient, hospitalized on July 20th for neurological and respiratory distress after emergency surgery for a subdural hematoma on July 19th. He had a history of atrial fibrillation, chronic obstructive pulmonary disease, asthma, and heart failure. The patient was catheterized (urinary, gastric, and peripheral) from July 19th to July 27th and was intubated and ventilated during the same period, receiving parenteral nutrition. On July 24th, the patient developed a fever, and a blood culture revealed the presence of *Klebsiella pneumoniae*. Unfortunately, the patient passed away on July 27th before antibiotic treatment could be administered.

The third case, reported in the Orthopedic Department on July 29th, 2022, involved a 66-year-old female patient who had been hospitalized on July 7th and underwent surgery for a femoral neck fracture on July 17th. The fracture occurred at a site of bone neoplasia following a fall. The patient had a history of stroke, diabetes, and hypertension but no extrinsic risk factors other than the surgery. Two days post-operation, she developed a fever. She was also confirmed to have COVID-19 on July 15th, which required isolation. A blood culture during her hospitalization tested positive for methicillin-resistant *Staphylococcus aureus* (MRSA), and she was treated with Augmentin and Ciprofloxacin. On July 29th, a pus sample from the surgical site tested positive for *Klebsiella pneumoniae*.

Questions

Question 8: What are the common risk factors among the three patients that could have contributed to the development of carbapenem-resistant *Klebsiella pneumoniae* infections?

Question 9: What other information should be illustrated in the case description?

Table 1: Hospitalization history of the three infected patients of Multi Resistant *Klebsiella Pneumonia* in Sahloul University Hospital-2022

Case	Department	Admission date	Reason of admission	Invasive acts	Date and site of infection		ATB	Evolution
1	**Neurosurgery department then PSO department**	July 20th, 2022	Subdural hematoma	PKT + PVR +UKT+ GT+ intubation	July 27th, 2022	-BC	0	Patient died on July 27th 2022
2	**Surgical resuscitation**	July, 2nd 2022,	complicated cholecystitis	CKT +PKT + UKT	July 27th, 2022:	GT swab	Tienam, amiklin-fortum	Still hospitalized
3	**Orthopedics**	July 7th, 2022	Femur neck fracture	Operation for his fracture+ PRV	July 29th, 2022 deeper	CBEU, BC	Vanco→fosf o-coli	Resumption of his surgery on August 3rd, 2022, because of pus in the wound. Still hospitalized

PKT: peripheral catheterization - CKT: Central catheterization - UKT: urinary catheterization – PVR: peripheral venous route - GT: gastric tube

Question10: Create a synoptic chart with time on the x-axis (abscissa) and patients on the y-axis (ordinate):

1. **Gather Data**: Collect the relevant data for each patient, including the time of onset of symptoms, diagnosis, or any other key events.
2. **Choose a Time frame**: Decide on the time frame that you want to represent on the x-axis. This could be hours, days, weeks, or months depending on the duration of the events you are tracking.
3. **Organize Patients**: List the patients on the y-axis. Each patient will have a corresponding line or marker to represent their data over time.
4. **Plot the Events**: For each patient, plot the events or data points on the chart according to the time they occurred. Use different symbols, colors, or line styles to represent several types of events.
5. **Label and Annotate**: Label the axes clearly and provide any necessary annotations to explain the data, such as what each line or symbol represents.
6. **Review and Interpret**: Once the chart is complete, review it to ensure that it accurately represents the data and helps to visualize trends, clusters, or outliers.

The patients were in contact with some medical and nursing staff as well as the other patients. The different contact cases are summarized in Table 2.

Table 2: The contact cases of the three infected patients of Carbapenem resistant *Klebsiella Pneumonia* in Sahloul University Hospital -Sousse-2022

Department	**Number of patient contacts**	**Number of nursing staff**
Surgical resuscitation	0	1 internal 1 resident 1 physiotherapist 1 nurse

PSO	0	2 nurses 1 internal 1 resident 1 physiotherapist
Orthopedics	2 and the patient was isolated as soon as her positive PCR was declared in July 15th2022	1 resident 1 internal 3 nurses

The geographical description of the departments where the patients were hospitalized are shown in figure 2 and 3. The first floor contains on the right side the resuscitation department, in the centre the PSO department, the laboratories and the different operation theatres including the operating room 'O2' common between orthopedic and neurosurgical theatres. The fourth floor contains the orthopedic department with the isolation room in red.

Question 11: What can be inferred from the geographic distribution of the cases and the departments involved regarding the possible routes of transmission?

Environmental Survey: Samples were taken in the different hospitalization rooms: 11 samples in room A3 of surgical resuscitation department, 11 samples in room O2 of the operating theatre (shared room between the orthopedic department and the neurosurgery department),9 samples in the orthopedic isolation room and 9 hand samples from medical and paramedical personnel, including 3 in each department. No samples taken in the PSO department because the patient was no longer hospitalized, and the room was completely disinfected 3 times. The results of the environmental survey were summarized in table3.

Table 3: Results of the environmental survey in the three patients' departments in Sahloul University Hospital-August 2022

Designation	Nature of non-compliance	Total
A-Surgical resuscitation department: Room A3		
Care trolley	Presence of total germs	(0 CFU/25cm2)
patient bed	Presence of total germs MO indicator	(65 CFU/25cm2) *Pseudomonas aeruginosa*
antiseptic bottle	Presence of total germs	(1 CFU/25cm2)
Scope column	Presence of total germs	(7 CFU/25cm2)
Work bench-chamber door-syringe pump	Presence of total germs	(1 CFU/25cm2)
Sink siphon	Presence of total germs	(>300 CFU/25cm2)
B-Orthopedics Isolation room		
Sink siphon	Presence of total germs and Acinetobacterspp	(54 CFU/25cm2)
sick table	Presence of total germs and filamentous fungi	(22 CFU/25cm2)
bed table	Presence of total germs	(0 CFU/25cm2)
rehabilitation chair	Presence of total germs and filamentous fungi	(15 CFU/25cm2)
patient bed	Presence of total germs	(2 CFU/25cm2)
Wrist Gate	Presence of total germs and Aspergillus	(3 CFU/25cm2)
Stem	Presence of total germs	(1 CFU/25cm2)
C-Orthopedics /O2 room of the operating theater		
Sink siphon	Presence of total germs	(0 CFU/25cm2)
storage table	Presence of total germs	(20 CFU/25cm2)

Respirator	Presence of total germs and filamentous fungi	(3 CFU/25cm2)
Emergency trolley	Presence of total germs and filamentous fungi	(5 CFU/25cm2)
Wrist Gate	Presence of total germs	(6 CFU/25cm2)
Stem	Presence of total germs	(0 CFU/25cm2)
scialytic	Presence of total germs	(7 CFU/25cm2)
D-Hands of manipulators		
Hands from six manipulators	Presence of total germs	(147 U/25cm2)

Question 12: Interpret the results of the environmental survey

Audit of good practice:

The audit results are summarized in Table 4:

Table 4: Audit of the standard hygiene precautions in the infected patients' hospitalization environments

Observation	Surgical resuscitation	PSO	Orthopedics
Hand hygiene			
Liquid soap always available	Yes	Yes	No
Liquid soap available from all water points	**Yes**	**No**	**No**
Hydroalcoholic product	**Yes**	**Yes**	**No**

continuously available			
Paper continuously available at all water points	**No**	**No**	**No**
Clean gloves are continuously available	**Yes**	**Yes**	**No**
Hand hygienerespected	**Yes**	**No**	**No**
Equipment and personal protection			
Existence of glasses	**No**	**No**	**No**
Existence of protective mask	**Yes**	**Yes**	**Yes**
Existence of overcoat	**No**	**Yes**	**No**
Existence of gloves	**Yes**	**No**	**No**
Care and antiseptic trolley			
Presence of a care trolley for each patient	**Yes**	**Yes**	**No**
The antiseptics are in the original bottles	**No**	**No**	**No**
Antiseptics are wellprotected	**No**	**No**	**No**
Antiseptics are welllabeled	**No**	**No**	**No**
A lack of nursing staff	**No**	**Yes**	**No**
General state of cleanliness	**Very Good**	**Good**	**Poor**

Question 13: interpret the results of the audit:

Measures implemented:

To stop the spread of this resistant infection, some general measures were highlighted, such as: Septic isolation of infected patients (geographical and technical), reinforcement of general precautions for all patients, daily bio-cleaning of the rooms, stopping patient transfers (index and contacts) to other units or departments to limit dissemination,

Verification of compliance with the bio-cleaning procedure: product, dilution, application time, etc. Hand hygiene: hydroalcoholic hand rubbing and providing training sessions on hand hygiene.

Specific measures were also mentioned, as in the event of compulsory transfer of the patient, carrying must be clearly mentioned in the hospitalization reports and in the transfer letter. If there is a risk of contact with biological fluids: wearing personal protective equipment (gloves, long-sleeved gown, mask) adapted to the risk assessment, and If the patient "case *Klebsielle pneumoniae*" has already been transferred to another department between the time of the sample which allowed the diagnosis and the time when his status was confirmed, these measures apply to the department of origin and to the host department. And the necessity of cleaning disinfection of equipment by the cleaning staff od the infected departments such as of the Surgical resuscitation and Orthopedics departments

Cases evolution and hypothesis

The implementation of these measures made it possible to control the epidemic. The patient in the resuscitation department was discharged on august 24th 2022 with negative infectious assessment. The orthopedic patient was still hospitalized with persistent fever and poor general condition.

A new case of carbapenem drug-resistant *klebsiella pneumoniae* was declared in August 25th2022 in a patient hospitalized in the urology department. This germ was imported since the patient was transferred from Nabeul hospital while having this germ in the removal of deep pus from his operative wound. The personnel of the departments concerned have been informed of the epidemic and the patient has been isolated.

From the information collected on the characteristics of the cases, the notion of patient transfers between the departments as well as the sharing of operating rooms, especially since the 2 patients in orthopedics and neurosurgery were operated on in the same room 'O2', two hypotheses were discussed:

- *Assumption on the mode of transmission:* the transmission of epidemic clones can be carried from staff in the O2 block.
- Transmission by the residents of the resuscitation department who work during the morning in different operating rooms and circulate during the night shifts in other departments.
- *Reservoir Assumption:*
- Since the germ can persist on surfaces, improper disinfection of frequently touched surfaces in the patient's environment may be implicated in causing this outbreak.

Part 4: Discussion

It is an epidemic of HAI due to a strain of MDRO: *Klebsiella pneumoniae*. It concerned three cases of patients with intrinsic risk factors (multi-targeted), and extrinsic (invasive procedures: gastrostomy, vascular catheterization, urinary catheter…).

The three strains isolated had the same antibiotic type characterized by resistance to all antibiotics except Fosfomycin and colistin.

This epidemic during COVID-19 pandemic can be explained by the notion of both inciting and moderating effects of the COVID-19 pandemic on the incidence of MDRO[7,8].

A systematic review studying the changes in the rate of MDRO showed an increase in the rate of multidrug resistant gram positive and gram-negative bacteria during the COVID-19 pandemic. However, in contrast with the findings of our study, the rate of ESBL-producing Enterobacteriaceae and CRPA has decrease during the pandemic[9].

The risk of infections is highly prevalent especially in resuscitation and surgical departments and this, for many reasons[10]. First the hospitalized patients are more physiologically vulnerable due to their medical history, their lower immunity[11]. Second the hospital environment has a significant role in the implantation of the pathogens. moreover, the resuscitation and surgical specialities commonly require a specific use of antibiotics because of the frequent infections among

the patients[12]. This high consumption generates a selection pressure which generates MDRO that rapidly colonize and infect patients.

Resuscitation patients are generally heavy patients requiring the quasi-systematic use of invasive devices (catheterization, intubation) which represent entry points for infections. In fact, our three patients benefited from a urinary catheterization and two of them were intubated.
The risk factors found in our study are online with factors facilitating the spread of MDRO documented in the literature including health-care worker -patient contact, inadequate adherence to hygiene precautions, low staffing, breaches in environmental cleaning and inadequate antibiotic use[13]. These characteristics contribute to a decrease in patients' resistance to exogenous bacteria and to an increase in cross-infection risks.
The investigation in its descriptive phase did not make it possible to direct towards a clear source of transmission, however the confrontation of the data of the literature with a most widespread mode of manual transmission and an effectiveness of the measures of reinforcement of standard measures of Hygiene having stopped the epidemic suggests a very probable hand-borne transmission[14].

The measures we put to control this outbreak were the main solution to contain the outbreak. First, we reinforced standard precautions and implemented contact precautions: we isolated case patients in single rooms, and we strictly adhered to measures to avoid contact with and transmission of infective agents (i.e., wearing gloves when entering the room, changing gloves after contact with infective material, wearing gowns during procedures likely to generate splashes, adequately cleaning and disinfecting environmental surfaces, and not using reusable equipment for the care of another patient until it was cleaned and reprocessed appropriately). These findings are keeping with current recommendations reported in the literature[15–17], as many studies aimed to show the importance of strengthening the infection control practices and the early detection of such epidemics[18–20].

Strong points:

This investigation was set up quickly as soon as the cases of *Klebsiella pneumoniae* were reported by the microbiology laboratory, an identification of failures in relation to the application of standard hygiene precautions was identified and corrective measures were put in place immediately. which made it possible to stop the extension of this HAI.

Weak points

- The main weak points of this investigation were the delay in microbiological investigations of the care environment, which were only implemented after a disinfection intervention, reinforcement of standard precautions (prior agreement from the regional hygiene laboratory was necessary and not granted in a timely manner).
- The other weak points concerned the impossibility of carrying out the investigation of faecal carriage (sampling by rectal swab or stool) among the contact patients and the nursing staff, given the lack of culture media which could be at the origin of a source of contamination by asymptomatic carriers which could be at the origin of other epidemics.

Part 4 Questions

Question 13: How did the COVID-19 pandemic potentially influence the incidence of multidrug-resistant organisms (MDRO) in this outbreak, and what specific factors related to the pandemic may have contributed to the spread of Klebsiella pneumoniae in this hospital setting?

Question 14: What role did the hospital environment, and invasive procedures play in the proliferation and transmission of Klebsiella pneumoniae in these cases, and how might improvements in these areas reduce the risk of future outbreaks?

Part 5: Case study conclusion

The rapid identification of outbreaks of healthcare-associated infection thanks to a reactive surveillance system, and the implementation of a rigorous investigation and urgent corrective measures made it possible to stem the spread of this healthcare-associated infection. with multi resistant germ having a heavy load of Morbi-Mortality

Question 15: summarise the steps of an outbreak investigation

Question 16: What actions would you take to engage the community while implementing prevention and control measures?

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