Antimicrobial Resistance and Infection Control

CORRESPONDENCE

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Establishing carbapenem resistant organism surveillance, prevention, and control in a middle-income country: implementation of a hospital-based program in Fiji

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Abstract

Antimicrobial resistance (AMR) is a major public health threat with the highest burden being estimated to be in low- and middle-income countries. Fiji is an upper-middle-income country in Oceania. Recent studies from Fiji highlighted the increasing burden of carbapenem resistant organisms (CRO) such as *Acinetobacter baumannii*, *Pseudomonas aeruginosa* and *Escherichia coli*. A project titled Preparing Fiji for Pathogens with Critical Antimicrobial Resistance was undertaken at the Colonial War Memorial Hospital, Fiji's main referral hospital, in 2022 and 2023. The overarching goal was to support the hospital's readiness for prompt detection, management and prevention of infections caused by pathogens with critical AMR including CRO. This paper describes the steps taken to establish CRO surveillance, prevention, and control interventions, outbreak response and healthcare workers' capacity building initiatives tailored to the hospital's need and capacity. It also shares the results, lessons learned and challenges in setting up the systems that may inform actions in other low- and middle-income countries in the Pacific Region and globally.

Keywords Antimicrobial resistance, Capacity building, Carbapenem-resistant, Fiji, Infection prevention and control, Low- and middle-income countries, Surveillance

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Introduction

Antimicrobial resistance (AMR) is a major public health threat with the highest burden being estimated to be in low- and middle-income countries [1, 2]. It has been estimated that AMR directly caused 1.27 million deaths globally in 2019. Of these, 286,040 deaths were in the World Health Organization (WHO) Western Pacific Region (WPR) which includes the Pacific Island Countries (PIC) [1]. Poor awareness, lack of national surveillance systems to monitor AMR, poor regulation of antimicrobials, and sub-optimal health system responses to outbreaks of AMR pathogens are among the major challenges to combating this problem in the WHO-WPR [3]. AMR awareness, surveillance and research are priority action agendas for the region [4]. In particular, there is a need to address the paucity of data related to how to best control AMR in PIC [5–7]. In Fiji, outbreaks of multidrug resistant healthcare associated infections with high fatality rates have been reported [8–10]. More recently outbreaks of carbapenem resistant organisms (CRO) such as *Acinetobacter baumannii* [11, 12], *Pseudomonas aeruginosa* and Enterobacterales including *Escherichia coli* have been reported in the country's main referral hospital [13–15].

A project titled "Preparing Fiji for Pathogens with Critical Antimicrobial Resistance" was undertaken at the Colonial War Memorial Hospital (CWMH) in Fiji from May 2022 to December 2023, supported by an Australian Government Medical Research Future Fund and the WHO Collaborating Centre for AMR at the Peter Doherty Institute for Infection and Immunity at the University of Melbourne, Australia. The overarching goal of the project was to support the hospital's readiness for prompt detection, management and prevention of infections caused by pathogens with critical AMR including CRO. The project team comprised of local and international experts across clinical care, infection prevention, microbiology laboratory, genomics, epidemiology and antimicrobial stewardship. While building preparedness, the team recognised several endemic and epidemic CROs, developed a shared understanding of these in real time, and implemented actions to control the transmission and treat affected patients with the support of healthcare leaders in collaboration with broader local stakeholders. This paper describes the steps taken to establish CRO surveillance, prevention, and control interventions as well as an outbreak response in the CWMH and shares the results and lessons learned in setting up the systems that may inform actions in other countries in the Pacific Region and globally.

Methods

Study site

This capacity building program was focused on CWMH which is located in Suva, the capital city of Fiji, CWMH is the largest referral hospital in Fiji with a 566-bed capacity. Services available include surgery, anaesthesia, obstetrics & gynaecology, paediatrics, internal medicine, intensive care units (ICU) (adult, maternity, neonatal and paediatric), high dependency units (burns and cardiac care), accident and emergency, microbiology laboratory and other sub-specialties.

In-country consultation and project agreement

On 10 November 2021, a virtual consultation meeting was conducted with the chair of the CWMH Infection Prevention and Control Committee (IPCC), Manager Clinical Governance (CG), the Infection Prevention and Control (IPC) team and the national AMR focal point to identify priority pathogens and define the scope of the project. The local team nominated CROs as they had experienced a hospital-based outbreak in 2017 and noted a steady increase in CRO cases since then. In March 2022, a formal project agreement was signed between the Fiji Ministry of Health and Medical Services (MOHMS) and the University of Melbourne. Desktop review of literature and available guidelines, policies, and standard operating procedures (SOP) were carried out to gather background information on AMR and understand existing governance and prevention strategies (Fig. 1). Results of a recent readiness assessment describing general capabilities in antimicrobial stewardship, IPC, water, sanitation and hygiene (WASH) and the microbiology laboratory were also reviewed [16]. A project workplan was developed together with agreed expected outcomes.

Human resources support

Three in-country project staff (IPC project coordinator and laboratory technicians) were employed at the hospital. These local project staff worked in close collaboration with the respective existing hospital teams to support capacity building activities and monitor progress (Supplementary Table S1). A project manager and IPC clinical nurse consultant based in Melbourne also directly supported the project activities. In addition, microbiologists, IPC, WASH specialists and infectious diseases (ID) physicians from Melbourne provided mentorship and ongoing technical support.

IPC and laboratory baseline capacity assessment

A tabletop simulation and walkthrough exercise on site were conducted to determine the hospital's baseline

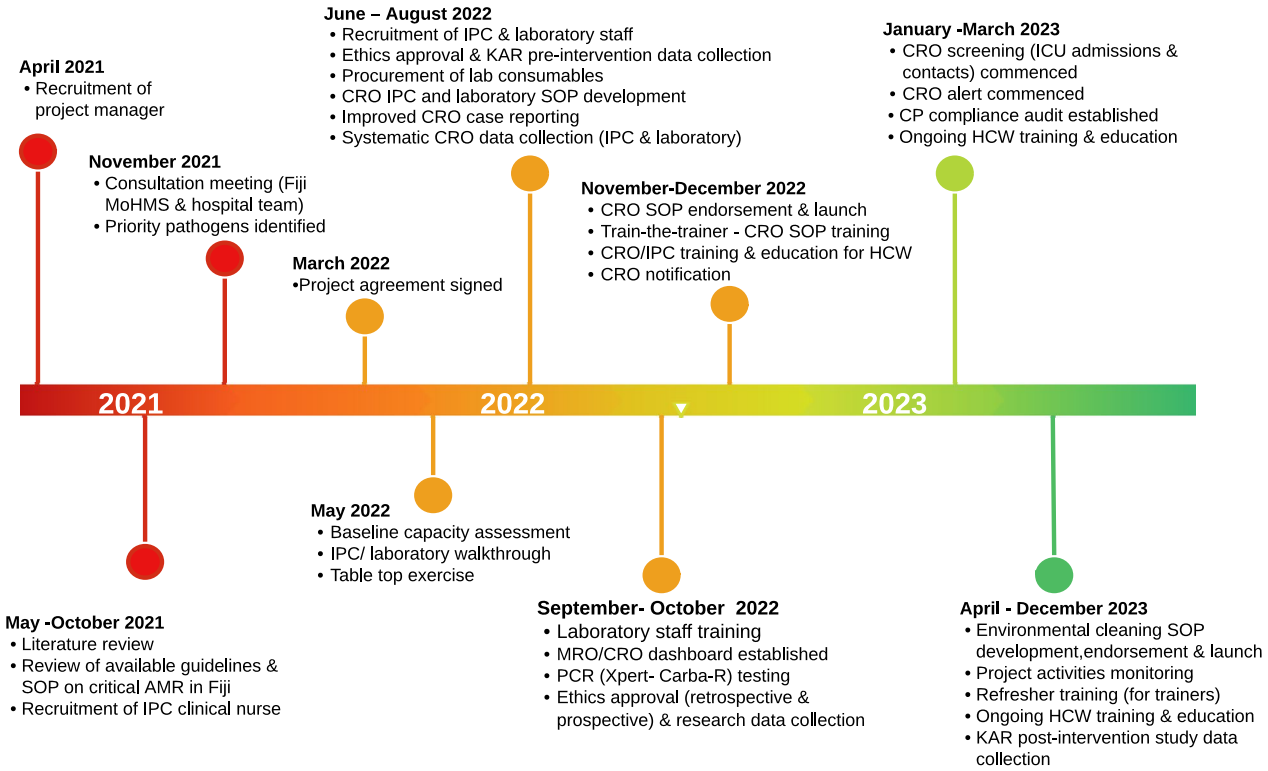

Fig. 1 Project timelines for key activities. AMR = Antimicrobial resistance, CP = contact precautions, CRO = Carbapenem resistant organisms, CWMH = Colonial war memorial hospital, HCW = Healthcare workers, IPC = infection prevention and control, KAR = Knowledge, attitude, and readiness, MoHMS = Ministry of Health and Medical Services, PCR = Polymerase chain reaction, SOP = Standard operating procedures

IPC, WASH and laboratory capabilities and to identify additional needs to improve CRO detection and patient management. The tabletop exercise was conducted via a facilitated discussion with hospital staff using a set of scenarios about AMR pathogens. Participants were encouraged to discuss their perceived roles, what actions they would undertake or be responsible for and what resources were available to support them. Priority wards were identified for the walkthrough exercise in consultation with the IPC team. A standardised checklist was used to collect baseline ward data on practical measures to manage patients with CRO. This included: number of nursing staff per shift, ward configuration, patient placement and transfer practices, availability of hand hygiene (HH) facilities and personal protective equipment (PPE) supplies, toilet facilities and environmental cleaning practices, and available antimicrobials to treat affected patients. Data was collected through observation and staff interview. The microbiology laboratory walkthrough was conducted to assess the capacity for CRO detection and understand reporting mechanisms. Additional laboratory consumables needed for CRO detection were identified. Procurement planning included liaising with Fiji Pharmaceutical & Biomedical Services for biosecurity import permits, in-country customs clearance, transportation (including controlled temperature requirements) and timely delivery.

A baseline cross-sectional study was conducted to determine the knowledge, attitudes, and readiness of healthcare workers (HCW) about critical AMR and IPC [17]. The pre-intervention survey results were used to guide capacity building activities. This same survey was readministered at the end of the project to monitor for change [17].

Education and communication

A train-the-trainer approach was used to provide education to the hospital's HCW and raise awareness about AMR. Standard training PowerPoint slide sets and educational videos were prepared. Furthermore, in-country training, mentorship and ongoing support via fortnightly online meetings were held with microbiologists, ID physicians and IPC specialists in Melbourne, Australia. Patient education materials were developed to suit the Fijian context and translated into the local language.

Results and discussion

Baseline IPC and laboratory capacity assessment findings

The hospital IPC team consisted of four nurses, including one acting team leader. The hospital has an IPCC, but it had not been meeting regularly at the time of the baseline assessment. The microbiology laboratory had 10 laboratory scientists and technicians.

A three-hour facilitated tabletop exercise conducted on 11 May 2022 was attended by 34 participants. The ward walkthrough was conducted over two days (10 and 12 May 2022). A total of eight wards including acute medical and surgical wards, emergency, post-natal and ICUs were included in the walk-through assessment. Except for nurse unit managers (NUM), ward nurses worked 12-h shifts. The nurse-to-patient ratio ranged from 1:2 in the ICU to 1:5 in the acute and post-natal wards. The wards were multi-bed open layout with curtains between beds. Beds in several wards were spaced less than a metre apart. There were no single rooms with ensuite bathroom and toilet which could be used for isolation of patients with CRO infection or colonization. There was one isolation room (containing four beds) with a dedicated bathroom/ toilet in each acute ward. Visitors and family members often supported patient care on medical and surgical wards.

The main adult ICU had eight beds, two in each cubicle separated by a wall. Beds were well spaced apart. There were two separate isolation rooms adjacent to the main ICU which were not in use during the visit. The neonatal ICU (NICU) consisted of three separate rooms (all multi-bed) with a total of 24 bed capacity. One of the rooms (four beds) was used as an isolation ward. In addition, there was a stepdown room for NICU in the post-natal ward. The paediatric ICU was a single room with six beds. It had a separate isolation room (four bed) with a toilet. Shared handwashing sinks for patients (ranging from 1 to 3) were available in all wards. The adult ICU had one sink per bed. Most sinks were functional and equipped with soap and paper towels with HH education material displayed. Alcohol-based hand sanitizer bottles were usually available at the bed side or at a minimum at the entrance to a room. All patient toilet facilities on wards were shared (designated by gender), and most toilets did not have soap or paper towels available at the time of visit. Nurses interviewed stated that PPE was readily available for them.

Cleaning of the hospital was outsourced to a private company and the hygiene staff were shared between wards. Generally, the hygiene staff were responsible for all environmental cleaning except in high-risk wards such as ICU and the operating theatre where cleaning was done by ward assistants and nurses. A 3-step cleaning procedure (detergent and water, disinfectant and a final rinse with water) was used for environmental cleaning. Floor, surfaces and toilets were cleaned 2–3 times a day. Nurses were responsible for cleaning shared patient equipment at the bedside (e.g., stethoscope, blood pressure cuff), and for cleaning the immediate patient space (e.g., over bed table). Detergent/disinfectant wipes were not readily available on wards.

There were no locally adapted IPC SOPs available however, the 2010 general IPC guidelines developed by the Pacific Public Health Surveillance Network were referred to. There were also no specific SOPs for CRO case and contact management or environmental cleaning, although some flowcharts outlining cleaning procedures were sighted on the wards. There was no specific outbreak management plan for CRO outbreaks. However, staff reported that in 2017 a team from the WHO investigated a carbapenem resistant *A. baumannii* outbreak in NICU and recommended control measures. For risk communication, the treating medical and IPC teams usually informed patients and carers verbally about the CRO. There were no patient education leaflets or pamphlets regarding CRO.

The microbiology laboratory had the capacity to identify meropenem resistance using the disc-diffusion method and carbapenemase production using the modified carbapenemase inactivation method. There was no capacity to detect carbapenemase genes using polymerase chain reaction (PCR) or whole genome sequencing (WGS). There were approved SOP for all procedures performed in the laboratory.

Development and implementation of SOPs for IPC

A specific SOP for management of cases with CRO and their contacts was developed by the project team in consultation with the IPC team, wider hospital team and other local stakeholders. This was formally approved by the hospital IPCC in November 2022 and implemented through an education and training program. The recommendations within the SOP were informed by international publications [18–20], but were adapted for the local CWMH context. The main aim of the SOP was to provide evidence-based recommendations for prompt case detection and effective IPC management for priority pathogens including carbapenem resistant *A. baumannii*, *E. coli, K. pneumoniae,* and *P. aeruginosa*.

The preferred management of cases with CRO infection or colonisation is usually to isolate patients in a single room with its own ensuite with contact precautions (CP) in addition to standard precautions [18, 20]. However, at CWMH this was not practical to recommend. Therefore, it was agreed to isolate patients in a designated area within the wards further away from other patients and ensuring at least one metre between beds for IPC

measures and patient/staff movement. An alternative isolation and CP strategy was cohorting patients with the same organism in the same four-bed isolation room. When CP were utilized at the bedside, a CP sign was placed close to the patient, a donning station was set up outside the patient zone and the doffing station inside the patient zone. Other recommendations included limiting movement of the patient, ensuring CP during any patient transfers, dedicating medical equipment where possible (or otherwise cleaning and disinfecting shared equipment after patient use), and daily cleaning of the patient zone. The procedure also advised on enhanced case finding using screening of high-risk groups and ward contacts (Supplementary Table S2). The SOP had a section on outbreak investigation and management.

Specific systems for notification and alert of patients infected or colonized with CRO were established. Pathways to ensure timely notification from the laboratory to ward staff, treating clinicians, IPC staff and hospital leadership were clarified with roles and responsibilities defined. The IPC team documented CRO notification on the front page of the patient's medical folder and a CRO alert was added to the electronic patient information system for prompt identification of known CRO cases during subsequent admissions. Patients were provided with a CRO patient information leaflet and ward staff were educated on what information needed to be explained to patients and their care providers. IPC nurses also reviewed all CRO patients to ensure required IPC measures were in place.

Audit tools were developed to monitor compliance of HCW with recommended practices including appropriate patient placement/isolation, donning and doffing procedures and cleaning. Audit findings showed steady improvement in general donning and doffing practices. For example, the proportion of HCW who donned PPE in the correct order improved from 64% in 2023 to 76% in 2024. Similarly, 86% of HCW audited in 2024 followed the correct steps to remove PPE compared to 71% in 2023. HH compliance rates improved from 55 to 68% before donning and 31% to 48% after removing gloves.

Active screening for CRO colonization

Active screening on high-risk wards commenced in January 2023 which enabled early detection of CRO colonisation and appropriate management. Pre-emptive screening was conducted on all new adult ICU admissions and post-contact screening of patients who were deemed to be close contacts of any new case. For NICU, all newborns in the same room as a new case were deemed to be close contacts and were therefore screened. In addition, mother-newborn pairs were considered as close contacts and screened if either the mother's or baby's clinical or screening samples grew CRO. New admissions to the adult ICU were screened within 72 h of admission. Initially, post-contact screening was conducted seven days after detection of a new case. Due to a lack of a functional bed management system, it was not possible to follow up patients for this period of time. Therefore, post-contact screening was initiated immediately after confirmation of a case and a second sample was taken five to seven days later or before discharge when possible. Screening was conducted by collecting a rectal swab or stool for culture. Patient or guardian consent was obtained prior to collecting samples. The rate of ICU admission screening increased from 23% in January to 77% in December 2023. Overall, 70% of all new adult ICU admissions were screened in 2023. ICU admission screening continued through 2024, and coverage ranged from 31 to 71% in the first six months.

Development and implementation of laboratory SOP

New laboratory SOPs were developed to guide detection of CRO. This included SOPs for processing screening samples using CHROMAgar™ mSuperCARBA™, detection of carbapenem resistant genes using Xpert® CarbaR, storage of bacterial isolates in ultra-low temperature and preparation and shipment of isolates for WGS. All SOPs were approved for use by the Head of Pathology. Bench workflows were prepared for the new SOP. Other existing SOPs were revised and updated as needed. Essential consumables including meropenem discs and CRO selective media were procured. In addition, PCR testing kits for detection of five carbapenem resistance determining genes namely: *bla*KPC (KPC), *bla*NDM (NDM), *bla*VIM (VIM), *bla*OXA-48 (OXA-48), and *bla*IMP (IMP) were made available.

Development of environmental cleaning SOP

Following the baseline assessment of the IPC SOPs, it was determined that development of a general environmental cleaning SOP was a priority. A complete review of the cleaning practices, duties lists, products used, and audit tools was undertaken. A new 2-in-1 cleaning and disinfection product was introduced with the aim of simplifying environmental cleaning and disinfection in high priority wards (ICU, NICU and some acute wards). Roles and responsibilities for cleaning tasks were clarified and documented, as were daily and discharge cleaning checklists for patients with a CRO. Use of a fluorescent ultraviolet marker was included as part of the audit tools developed to assess compliance with the new procedures and for training proposes. The new SOP and audit tools were endorsed by the IPCC in June 2023. Two training sessions were conducted for 51 hygiene staff and nurses in March and May 2024. Audits (visual and fluorescent

marker) conducted between January through July 2024 showed overall improvements in cleaning compliance.

Training of IPC and laboratory staff

The project team trained (onsite and online) the IPC team on the new CRO management SOP as well as monitoring and follow up strategies. Subsequently, the CWMH IPC team conducted regular training and education sessions for hospital staff. Refresher training for all IPC and CG teams was conducted before the end of the project. As part of a concurrent program (the COMBAT-AMR project funded by the Australian Department of Foreign Affairs and Trade) four laboratory staff were able to travel to Melbourne, Australia to receive in-depth training in August and September 2022. During project implementation, a series of structured training and AMR education sessions were organised [17]. After the project, the hospital team continued to train new staff and organised IPC workshops and awareness programs. The regular online mentorship and meetings with microbiologists and IPC specialists have continued beyond the project end date.

CRO communication and surveillance

In addition to phone notification from the laboratory to the ward staff and IPC team, the laboratory team created a messaging group. Prompt reporting of laboratory results including type of CRO, the antimicrobial susceptibility pattern and carbapenemase production by phone and a messaging group enabled the IPC team to implement preventative measures immediately. The laboratory team established an online dashboard for CROs which is updated weekly and accessed by consultants to monitor case load. The IPC team also commenced collating CRO data which was shared with CG and consultants for effective case identification and management. The project also enabled a retrospective review of the microbiological data which provided a baseline antibiogram [14]. *A. baumannii* and *P. aeruginosa* were the most frequently reported CRO followed by *E. coli and K. pneumoniae.* Further genomic characterisation of isolates from infected and colonized patients identified NDM 1 & 7 and OXA-23 as predominant carbapenemases [15]. Other globally prevalent carbapenemase genes such as KPC and OXA-48 were uncommon in Fiji. These data were used to inform a revision of the empiric treatment guidelines for hospital acquired sepsis for patients in the ICU.

CRO outbreak control

In January 2023, while this project was progressing, the ICU clinicians recognized a cluster of patients with CRO. The project team supported the local staff to use their SOP to identify, understand and manage the outbreak. A small taskforce of epidemiologists, IPC and ID physicians visited to rapidly assist local teams to examine the data that had been collected. Genomics were used to track likely transmission pathways. The team became aware that several concurrent CRO outbreaks in the ICU and acute wards were occurring [15]. An Outbreak Management Team (OMT) was established in May 2023 to coordinate the CRO outbreak responses in the hospital. The OMT membership is comprised of the medical superintendent, IPC team, NUMs of the affected wards, physicians, microbiology laboratory scientist, and environmental cleaning support services. The OMT oversee implementation of the hospital's outbreak management plan, and all decisions and actions required for the outbreak response. Two CRO outbreaks were declared in NICU in June and August 2023. The OMT facilitated timely notification and reporting of cases as well as determining what additional resources and personnel were required to contain the outbreaks. The OMT continues to meet regularly, and recommendations are submitted to the IPCC for overall coordination.

As part of the CRO outbreak response, the OMT made a one-off submission to the National Medicine Therapeutics Committee for the procurement of newer and more effective antimicrobials including ceftazidime-avibactam + aztreonam, tigecycline and cefiderocol. The antimicrobials were procured by the Fiji MoHMS. Protocols for laboratory testing and treatment were prepared and the antimicrobials are currently in use for the treatment of CRO infections. The sustainability of procuring them can be challenging as the antimicrobials are not in the Fiji's essential medicine list due to high cost.

Coordination of CRO interventions

The hospital IPCC is delegated by hospital management (medical superintendent) to be responsible for coordination, monitoring and evaluating the IPC programme. The IPCC membership includes the director of nursing, hospital administrator, head of CG, head of medical unit, sister-in charge, theatre manager, representatives from stores, and pharmacy. Their scope is to set the minimum standards for the IPC program in CWMH with adapted evidence-based/best practice SOPs, development of IPC capacity, raising awareness of IPC, and developing and maintaining IPC links through link nurses, medical staff and the laboratory department. Following the COVID pandemic, there has been increased recognition of IPC and CG roles in preventing transmission of infections within the hospital. Their positions were further supported in partnership with the CWMH administrators who provided the IPC team with a newly designated office space, which was subsequently renovated and equipped to enable the team's ability to fulfil their IPC responsibilities effectively. The new Fiji National IPC

guidelines were released in May 2022. In collaboration with the Pacific Community and the Australasian College for Infection Prevention and Control, the Foundations of IPC course was undertaken by all CWMH IPC officers in 2023. Further IPC strengthening was undertaken at a national level which saw a significant review in the IPC consumable list to include approved cleaning and HH products that are aligned to the new IPC guidelines. The key lessons learned during project implementation and further opportunities for sustainability are listed in Supplementary Table S3.

Limitations and challenges

Infrastructure related constraints including limited toilets in acute wards, poor air conditioning in operating theatres, lack of clean utility rooms, presence of damaged hospital furniture and equipment which cannot be cleaned or disinfected properly, and crowding in the wards remained the main challenges. Other challenges encountered were frequent shortages and an inconsistent supply of essential cleaning and laboratory consumables. Other barriers were prohibitive diagnostic test costs, such as PCR and selective chromogenic agar. These kits were provided by the project and are not part of ongoing essential laboratory consumables. Given the high burden of CRO in the hospital, affordable and sensitive tests which can detect locally prevalent CRO, and resistant genes (including non-OXA-48) are needed for enhanced and sustained CRO surveillance. The shortage and high turnover of HCW in the hospital was another challenge. In 2022 and 2023, many nurses and laboratory personnel left their positions due to migration or private employment opportunities [21]. This required additional training, mentoring and supervision of staff to ensure continued compliance with established procedures. Further monitoring is required to assess for how long these interventions are maintained after the end of the project and determine their overall impact on CRO transmission and control in the hospital.

Conclusion

We established CRO surveillance, prevention and control strategies tailored to the facility's needs and capacity. Key themes that emerged from the project included improved CRO awareness among HCW, establishment of standards for CRO case detection and management which in turn improved timely reporting and initiation of IPC measures. Better communication and coordination across the hospital departments and improved detection of outbreaks and response were possible through the multidisciplinary IPCC and OMT. Finally regular audits and feedback provided opportunities for ongoing monitoring of interventions and finding solutions for identified problems. However, sustained support is required to address the main challenges (including infrastructure, consumables and human resources) and demonstrate continuous improvement of services resulting in reduction of CRO transmission in the hospital. This integrated approach involving IPC, CG, laboratory, clinical and hygiene teams to set up a system could potentially be adapted to suit other low- and middle-income countries in the Pacific and globally.

Abbreviations

AMR	Antimicrobial resistance
AST	Antimicrobial susceptibility testing
CG	Clinical governance
CAR	Critical Antimicrobial resistance
CP	Contact precautions
CRO	Carbapenem resistant organisms
CWMH	Colonial war memorial hospital
ICU	Intensive care unit
ID	Infectious diseases
IPC	Infection prevention and control
IPCC	Infection prevention and control committee
HCW	Healthcare workers
HAI	Healthcare associated infections
HH	Hand hygiene
KAR	Knowledge, attitudes and readiness
MoHMS	Ministry of Health and Medical Services
NICU	Neonatal intensive care unit
NUM	Nurse unit managers
OMT	Outbreak management team
PCR	Polymerase chain reaction
PIC	Pacific Island Countries
PPE	Personal protective equipment
SOP	Standard operating procedures
WASH	Water Sanitation and Hygiene
WHO	World Health Organization
WPR	Western Pacific Region
WGS	Whole genome sequencing

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s13756-025-01534-5.

Additional file 1.

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Author contributions

All authors contributed to the project implementation. AGS, SSK and MR prepared the first draft manuscript. KB, DC and TYS critically reviewed the draft manuscript, AGS, SSK, SP, TYS, MR, AD, AL, SAG, TR, IN, AV, SA, FH, RN, AS, DC, CL, CRL, AM, KH, RJ, BK, BPH, and KB read and approved the final manuscript.

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Availability of data and materials

No datasets were generated or analysed during the current study.

Declarations

Competing interests
The authors declare no competing interests.

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