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Article

Ten-Year Consecutive Targeted Surveillance of Healthcare-Associated Infections in the Pediatric Intensive Care Unit of a Children's Hospital

Yingchun Ran[1,*], Qinghua He[1], Qiong Luo[1], Xiao Liu[1], Xuelin Xia[1], Hongmeng Xie[1], Jing Zhou[1], Junhua Chen[1,*]

[1]Department of Infection Management, Children's Hospital of Chongqing Medical University, National Clinical Research Center for Children and Adolescents' Health and Diseases, Ministry of Education Key Laboratory of Child Development and Disorders, Chongqing Key Laboratory of Pediatric Metabolism and Inflammatory Diseases, 401122 Chongqing, China

*Correspondence: tongtong20100@163.com (Yingchun Ran); cjh460@163.com (Junhua Chen)

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Abstract

Aims/Background: Healthcare-associated infections (HAIs) represent a major public health challenge requiring urgent attention. These infections impose substantial burdens on both society and healthcare institutions. Patients in the pediatric intensive care unit (PICU) are at particularly high risk of HAI. This study aimed to analyze the status of targeted HAI surveillance in the PICU over 10 consecutive years and to provide evidence for improving HAI prevention and control strategies. **Methods**: Data were collected from PICU patients of Children's Hospital of Chongqing Medical University who were monitored through a real-time HAI surveillance system from January 2015 to December 2024. Collected indicators included HAI incidence, infection sites, incidence of device-associated infections, distribution of pathogens, and the detection rates and incidence of multidrug-resistant organisms (MDROs). **Results**: A total of 20,120 patients were monitored, with an overall HAI incidence of 3.36%. The annual incidence of HAI in the PICU exhibited a significant downward trend over the 10 years ($p < 0.001$). The respiratory system was the most common site of infection. The incidences of central line-associated bloodstream infection (CLABSI), ventilator-associated pneumonia (VAP), and catheter-associated urinary tract infection (CAUTI) were 0.70 per 1000 central line-days, 1.84 per 1000 mechanical ventilation-days, and 0.11 per 1000 urinary catheter-days, respectively. A total of 643 pathogenic strains were isolated, predominantly Gram-negative bacteria (73.41%), with *Acinetobacter baumannii* being the most frequently detected (18.35%). The detection rates of carbapenem-resistant *Acinetobacter baumannii* (CRAB) and carbapenem-resistant *Klebsiella pneumoniae* (CRKP) were 67.33% and 31.42%, respectively, both showing significant upward trends over the decade (both $p < 0.001$). The detection rate of carbapenem-resistant *Escherichia coli* (CREC) was 16.30% and showed a significant downward trend for 10 consecutive years ($p < 0.001$). The incidence of MDRO-related HAI was 0.68%, with CRAB (0.32%) and CRKP (0.13%) having the two highest incidence rates. **Conclusion**: The incidence of HAI in the PICU significantly decreased over the study period, indicating progress in infection prevention and control. However, CLABSI, VAP, and MDROs remain key priorities in ongoing HAI prevention efforts in the PICU.

Keywords: healthcare-associated infection; intensive care units; pediatrics

1. Introduction

A healthcare-associated infection (HAI) is defined as an infection that occurs in a patient during the course of care in a hospital or other healthcare setting, and was not present or incubating at the time of admission. A recent systematic review and meta-analysis reported that the global rate of HAI is increasing [1]. HAI is often associated with prolonged hospitalization and increased mortality, posing significant threats to patient safety and resulting in a significant socioeconomic burden. Consequently, HAI has emerged as a major public health concern worldwide [2,3]. A previous multicenter study identified HAI acquisition as an independent risk factor affecting all-cause mortality in intensive care units (ICUs). The mortality rate is 14.06% among ICU patients without device-associated HAI, increases to 31.14%–39.81% in those with one device-associated HAI episode, and reaches 46.56% in patients with three simultaneous device-associated HAI [4]. Moreover, HAI has been associated with increased length of hospital stay of 10.4 days [5]. Another study reported that HAI contributed to longer pediatric intensive care unit (PICU) stays (median 1.1 days without HAI vs. 4.0 days with HAI) and extended length of hospital stay [6]. In 2016 alone, HAIs accounted for $7.2 to $14.9 billion in healthcare expenditures in the United States [7]. In PICU settings, the mean additional cost per HAI was 144,711 Australian dollars, representing the highest health burden among hospital-acquired complications [6].

The PICU is a specialized environment designed for the management of critically ill children. These patients typically present with complex and severe clinical conditions, compromised immune responses, prolonged exposure to broad-spectrum antibiotics, frequent invasive procedures, and increased environmental risks, all of which make the PICU a high-risk setting for HAI [8]. Various studies have reported the incidence of HAI in PICU to range from 1.72% to 20.18% [9,10,11]. Prevention remains the fundamental principle of hospital infection control strategies and encompasses standard precautions (such as hand hygiene and isolation protocols), environmental management (including disinfection and air quality control), and evidence-based antimicrobial stewardship programs to mitigate antimicrobial resistance. Targeted surveillance represents a key strategy in the prevention and control of HAI. By enabling systematic data collection and analysis, it facilitates precise identification of high-risk points for infection. Evidence shows that targeted surveillance, combined with effective infection control interventions, can significantly reduce the incidence of HAI [12,13].

In recent years, most targeted HAI surveillance studies in intensive care units have focused on adult populations or general hospitals. In contrast, data on pediatric populations and pediatric specialty hospitals, particularly those with a high risk of infections, remain relatively limited. Therefore, a children's hospital conducted a decade-long (2015–2024) continuous targeted surveillance of HAI among hospitalized patients admitted to the PICU, aiming to provide evidence for improving HAI prevention and control strategies.

2. Methods

2.1 Study Subjects

This study included hospitalized patients (aged $\geq$1 month and $\leq$18 years) admitted to the PICU of the Children's Hospital of Chongqing Medical University between January 2015 and December 2024. The inclusion criteria were as follows: PICU admission duration greater than 48 hours, diagnosis of HAI confirmed by both HAI management specialists and clinical physicians, and infections occurring within 48 hours after transfer from the PICU. Exclusion criteria were: PICU admission duration $\leq$48 hours, and infections that were present or incubating at the time of admission.

2.2 Data Collection

The real-time automatic nosocomial infection surveillance system version 12.9 (Hangzhou Xinglin Information Technology Co., Ltd., Hangzhou, China) continuously collected infection-related data from PICU patients between January 2015 and December 2024. The scope of surveillance included the incidence of HAI, infection sites, incidence of device-associated infections, distribution of pathogens, detection rates of multidrug-resistant organisms (MDROs), and the incidence of MDRO-related HAI. MDROs in this paper specifically refer to carbapenem-resistant *Acinetobacter baumannii* (CRAB), methicillin-resistant *Staphylococcus aureus* (MRSA), carbapenem-resistant *Klebsiella pneumoniae* (CRKP), carbapenem-resistant *Pseudomonas aeruginosa* (CRPA), carbapenem-resistant *Escherichia coli* (CREC), and vancomycin-resistant *Enterococcus* (VRE). Diagnostic criteria were incorporated based on clinical manifestations, microbiological findings, and radiological evidence, following the HAI diagnostic standards issued by the Ministry of Health of the People's Republic of China [14].

2.3 Statistical Analysis

All statistical analyses were performed using IBM SPSS Statistics version 31.0 (International Business Machines Corp., Armonk, NY, USA). Categorical variables were expressed as frequency (n) and percentage (%). The trend χ^2 was used to assess the change in incidence across years. A p-value < 0.05 was considered statistically significant.

3. Results

3.1 Incidence of HAI

From 2015 to 2024, a total of 20,120 PICU inpatients were monitored, with 677 HAI cases and 769 HAI episodes. The incidence rate of HAI was 3.36%, and the episode rate was 3.82%. Over the ten consecutive years, the incidence of HAI in the PICU showed a statistically significant downward trend ($p < 0.001$), as shown in Table 1.

Table 1. Rates of HAI in the PICU from 2015–2024.

Year	Total inpatients (n)	HAI rate n (%)	HAI episodes n (%)
2015	1982	99 (4.99)	112 (5.65)
2016	2047	60 (2.93)	70 (3.42)
2017	1877	78 (4.16)	85 (4.53)
2018	1878	63 (3.35)	74 (3.94)
2019	1855	100 (5.39)	112 (6.04)
2020	1958	56 (2.86)	57 (2.91)
2021	2250	62 (2.76)	71 (3.16)
2022	2131	52 (2.44)	59 (2.77)
2023	2324	60 (2.58)	71 (3.06)
2024	2252	47 (2.09)	58 (2.58)
Global	20,120	677 (3.36)	769 (3.82)

Note: HAI, healthcare-associated infection; PICU, pediatric intensive care unit. Annual data are based on the number of hospitalizations within the year, while ten-year total data are deduplicated based on individual patients.

3.2 Distribution of HAI Sites

From 2015 to 2024, respiratory system infections were the primary HAI sites in the PICU. The top five infection sites were: lower respiratory tract not classified as ventilator-associated pneumonia (VAP), VAP, bloodstream infection (BSI) not classified as central line-associated bloodstream infection (CLABSI), CLABSI, and upper respiratory tract infection, accounting for 46.29%, 16.91%, 10.53%, 5.85%, and 4.29%, respectively. Device-

Table 2. Distribution of HAI infection sites in the PICU from 2015–2024.

Type of Infection	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Global
Upper respiratory tract	1	1	0	1	5	9	5	6	3	2	33
Lower respiratory tract (non-VAP)	55	23	48	38	55	33	36	23	29	16	356
VAP	24	22	17	9	18	0	5	7	12	16	130
BSI (non-CLABSI)	8	4	8	9	14	3	8	8	9	10	81
CLABSI	4	8	1	5	10	4	2	3	3	5	45
Gastrointestinal	9	5	5	0	3	2	0	2	3	1	30
Intracranial	2	1	1	2	0	2	8	4	6	0	26
Urinary tract (non-CAUTI)	3	0	1	1	3	2	1	2	3	4	20
CAUTI	1	2	0	0	0	0	0	0	1	0	4
Skin and soft tissue	2	0	0	1	2	0	0	0	0	2	7
Surgical site	2	2	1	5	1	2	5	0	1	1	20
Others	1	2	3	3	1	0	1	4	1	1	17

Note: HAI, healthcare-associated infection; PICU, pediatric intensive care unit; VAP, ventilator-associated pneumonia; BSI, bloodstream infection; CLABSI, central line-associated bloodstream infection; CAUTI, catheter-associated urinary tract infection.

associated infections totaled 179 cases, accounting for 23.28% of all infections. Details are presented in Table 2.

3.3 Device Utilization and Related Infections

From 2015 to 2024, the device utilization rates were 47.21% for central line (CL), 51.49% for mechanical ventilation (MV), and 27.30% for urinary catheter (UC). Corresponding device-associated infection rates were 0.70 per 1000 CL days for CLABSI, 1.84 per 1000 MV days for VAP, and 0.11 per 1000 UC days for catheter-associated urinary tract infection (CAUTI). Over the decade, CLABSI and VAP rates exhibited fluctuating downward trends but rebounded after 2021. In contrast, CAUTI rates remained consistently low throughout the study period. Details are provided in Table 3.

3.4 Distribution of Pathogenic Bacteria in HAI

A total of 643 pathogenic strains were isolated from 677 HAI patients, with Gram-negative bacteria predominating (73.41%). The six most commonly detected pathogens were: *Acinetobacter baumannii* (18.35%), *Pseudomonas aeruginosa* (11.66%), *Klebsiella pneumoniae* (9.95%), *Stenotrophomonas maltophilia* (7.15%), *Escherichia coli* (6.38%), and *Staphylococcus aureus* (5.44%). Details are presented in Table 4.

3.5 MDROs Detection

From 2015 to 2024, the detection rates of MDROs in the PICU, CRAB, MRSA, CRKP, CRPA, CREC, and VRE, were 67.33%, 47.03%, 31.42%, 19.22%, 16.30%, and 0.00%, respectively. Notably, CRAB and CRKP exhibited statistically significant upward trends ($p < 0.001$), while CREC demonstrated a statistically significant downward trend ($p < 0.001$). Details are presented in Table 5.

3.6 HAI With MDROs

From 2015 to 2024, the incidence of HAI attributed to MDROs in the PICU was 0.68%, with specific rates of 0.32% for CRAB, 0.13% for CRKP, 0.10% for MRSA, 0.09% for CRPA, and 0.03% for CREC. No VRE-associated infections were identified during the study period. Details are shown in Table 6.

4. Discussion

An analysis of 10 consecutive years of targeted surveillance data on HAI in the PICU of a children's hospital revealed an HAI incidence rate of 3.36%. This rate is higher than those reported in other domestic PICUs (ranging from 1.72% to 1.78%) [9,10], but significantly lower than the rates reported by Huang et al. [15] in China (19.40%) and Mohamed et al. [11] in Ethiopia (20.18%). Variability in HAI incidence across institutions may be attributed to differences in geographic settings, patient populations, diagnostic and therapeutic capacity, and the strength of infection surveillance and control systems. Over the 10-year monitoring period, this hospital demonstrated a statistically significant downward trend in HAI incidence in the PICU. This decline suggests that the infection prevention and control interventions implemented, explicitly designed for the PICU environment, have been effective. Key interventions included: (1) developing PICU-specific infection prevention and control protocols tailored to local epidemiological characteristics; (2) establishing standardized procedures for invasive interventions to minimize infection risks; (3) designating trained physicians and nurses as infection control monitors after formal competency-based training; (4) promoting a collaborative and responsive communication mechanism between the Department of Infection Management and clinical teams, supported by regular supervision, feedback, and ongoing educational sessions; and (5) conducting quarterly infection control quality review meetings to drive continuous quality improvement.

Table 3. Device utilization and associated infection rates in the PICU from 2015–2024.

Year	Stays (days)	CL days	CL utilization rate (%)	CLABSI cases	CLABSI rate (/1000 CL days)	MV days	MV utilization rate (%)	VAP cases	VAP rate (/1000 MV days)	UC days	UC utilization rate (%)	CAUTI cases	CAUTI rate (/1000 UC days)
2015	10,630	2345	22.06	4	1.71	3597	33.84	24	6.67	1585	14.91	1	0.63
2016	11,419	5198	45.52	8	1.54	6880	60.25	22	3.20	3628	31.77	2	0.55
2017	11,841	5004	42.26	1	0.20	7378	62.31	17	2.30	3824	32.29	0	0.00
2018	12,453	6678	53.63	5	0.75	7685	61.71	9	1.17	3990	32.04	0	0.00
2019	12,908	6566	50.87	10	1.52	8435	65.35	18	2.13	3899	30.21	0	0.00
2020	12,796	7235	56.54	4	0.55	6828	53.36	0	0.00	4691	36.66	0	0.00
2021	15,839	8009	50.57	2	0.25	7693	48.57	5	0.65	2095	13.23	0	0.00
2022	15,975	7892	49.40	3	0.38	7186	44.98	7	0.97	3247	20.33	0	0.00
2023	16,473	7647	46.42	3	0.39	7605	46.17	12	1.58	5270	31.99	1	0.19
2024	16,699	8113	48.58	5	0.62	7265	43.51	16	2.20	5177	31.00	0	0.00
Global	137,033	64,687	47.21	45	0.70	70,552	51.49	130	1.84	37,406	27.30	4	0.11

Note: PICU, pediatric intensive care unit; CL, central line; CLABSI, central line-associated bloodstream infection; MV, mechanical ventilation; VAP, ventilator-associated pneumonia; UC, urinary catheter; CAUTI, catheter-associated urinary tract infection.

Research on infection sites in PICU patients facilitates targeted resource allocation for enhanced monitoring and intervention in high-risk infection sites. The findings of this study indicate that HAI in the PICU predominantly involves the respiratory system, which is consistent with both domestic and international research [10,11,15]. These observations suggest that future priorities for HAI prevention and control should continue to emphasize the respiratory system. Patients in the PICU are generally immunocompromised and exhibit reduced respiratory defense functions due to immature airway development, coma, sedation, or underlying diseases. Frequent invasive respiratory procedures further increase the risk of respiratory system infections. Therefore, medical staff should strengthen nutritional support for PICU patients; minimize non-essential invasive procedures, and enhance compliance in hand hygiene. These measures are critical for reducing the incidence of respiratory system infections in this vulnerable population.

The CLABSI rate in this hospital was 0.70 per 1000 CL days, higher than previously reported rate in domestic PICU (0.50 per 1000 CL days) [9], yet lower than the rate reported by Yang et al. [10] (1.13 per 1000 CL days) and those from international studies (1.39–5.59 per 1000 CL days) [4,16,17]. The VAP incidence was 1.84 per 1000 MV days, which is lower than both national PICU reports (3.57–6.20 per 1000 MV days) [9,10] and international figures (4.03–8.08 per 1000 MV days) [4,17,18]. Continuous surveillance over the 10 years revealed an overall fluctuating downward trend in both CLABSI and VAP rates, suggesting that infection prevention and control measures implemented since 2016 have been effective. These interventions included bundle strategies, continuous quality improvement using quality management tools, specialized supervision, and the application of endotracheal tube inner-wall cleaning techniques to reduce the occurrence of VAP [19]. Evidence suggests that comprehensive and evidence-based preventive strategies can significantly reduce the incidence of CLABSI and VAP [20,21]. However, since 2021, a rebound in both CLABSI and VAP rates has been observed, indicating potential declines in adherence to protocols or emerging challenges in infection control. This upward trend highlights the need to establish sustainable, long-term infection prevention mechanisms and maintain strict vigilance in clinical practice.

The CAUTI incidence rate at this hospital was 0.11 per 1000 UC days, with multiple years reporting zero CAUTI cases, findings consistent with domestic PICU report [9] and significantly lower than international rates ranging from 1.33 to 7.2 per 1000 UC days [4,16,22]. Evidence indicates that effective and comprehensive infection prevention and control strategies can substantially reduce CAUTI incidence [23]. The sustained low CAUTI rate in this institution is closely associated with rigorous implementation of healthcare-associated infection control measures. These include strict adherence to indications for catheter placement, insertion performed exclusively by trained, competent, and experienced healthcare personnel, strict aseptic techniques during insertion and maintenance, the use of anti-reflux drainage bags, standardized daily perineal hygiene, and efforts to minimize both the frequency and duration of catheter use. A comparative analysis of domestic and international studies on device-associated infections in PICUs reveals that reported incidence rates in China are generally lower. This discrepancy may be partially explained by differences in case definitions, diagnostic criteria, surveillance methodologies, and reporting practices between Chinese and international guidelines.

Table 4. Distribution of pathogenic bacteria in HAI from the PICU.

Pathogenic bacteria	Strains (n = 643)	Constituent rate (%)
Gram-positive bacteria	132	20.53
Staphylococcus aureus	35	5.44
Streptococcus pneumoniae	32	4.98
Staphylococcus epidermidis	18	2.80
Enterococcus faecium	14	2.18
Staphylococcus hemolyticus	11	1.71
Staphylococcus hominis	5	0.78
Enterococcus faecalis	4	0.62
Others	13	2.02
Gram-negative bacteria	472	73.41
Acinetobacter baumannii	118	18.35
Pseudomonas aeruginosa	75	11.66
Klebsiella pneumoniae	64	9.95
Stenotrophomonas maltophilia	46	7.15
Escherichia coli	41	6.38
Elizabethkingia meningoseptica	31	4.82
Enterobacter cloacae	27	4.20
Serratia marcescens	12	1.87
Haemophilus influenzae	11	1.71
Others	47	7.31
Fungi	39	6.07
Candida albicans	26	4.04
Candida parapsilosis	4	0.62
Candida tropicalis	3	0.47
Others	6	0.93

Note: HAI, healthcare-associated infection; PICU, pediatric intensive care unit.

The present surveillance revealed that Gram-negative bacteria were the predominant pathogens responsible for HAI in the PICU, with *Acinetobacter baumannii*, *Pseudomonas aeruginosa*, and *Klebsiella pneumoniae* being the most frequently isolated species, findings consistent with previous domestic and international reports [9,11,15, 24]. The detection rates of MDROs of particular concern, CRAB, MRSA, CRKP, CRPA, and CREC, were comparable to those reported by the Chinese PICU Critical Infection Pathogen and Antimicrobial Resistance Surveillance Network during the same period [25]. The incidence of MDRO

Table 5. Detection of MDROs in the PICU from 2015–2024.

Year	*Acinetobacter baumannii*		*Staphylococcus aureus*		*Klebsiella pneumoniae*		*Pseudomonas aeruginosa*		*Escherichia coli*		*Enterococcus*	
	Strains	CRAB rate n (%)	Strains	MRSA rate n (%)	Strains	CRKP rate n (%)	Strains	CRPA rate n (%)	Strains	CREC rate n (%)	Strains	VRE rate n (%)
2015	113	53 (46.90)	60	29 (48.33)	64	13 (20.31)	79	13 (16.46)	77	12 (15.58)	15	0 (0.00)
2016	115	57 (49.57)	51	24 (47.06)	105	28 (26.67)	88	9 (10.23)	52	13 (25.00)	12	0 (0.00)
2017	114	55 (48.25)	67	34 (50.75)	81	15 (18.52)	96	21 (21.88)	57	14 (24.56)	10	0 (0.00)
2018	150	98 (65.33)	63	29 (46.03)	64	11 (17.19)	74	20 (27.03)	68	24 (35.29)	37	0 (0.00)
2019	175	128 (73.14)	58	27 (46.55)	61	29 (47.54)	69	11 (15.94)	54	12 (22.22)	36	0 (0.00)
2020	113	61 (53.98)	81	37 (45.68)	60	9 (15.00)	71	10 (14.08)	39	3 (7.69)	20	0 (0.00)
2021	213	167 (78.40)	98	36 (36.73)	78	23 (29.49)	73	13 (17.81)	43	4 (9.30)	34	0 (0.00)
2022	125	78 (62.40)	77	36 (46.75)	73	22 (30.14)	89	21 (23.60)	76	9 (11.84)	26	0 (0.00)
2023	107	78 (72.90)	97	55 (56.70)	93	40 (43.01)	113	20 (17.70)	66	1 (1.52)	25	0 (0.00)
2024	232	206 (88.79)	88	41 (46.59)	104	56 (53.85)	91	24 (26.37)	51	3 (5.88)	42	0 (0.00)
Global	1457	981 (67.33)	740	348 (47.03)	783	246 (31.42)	843	162 (19.22)	583	95 (16.30)	257	0 (0.00)

Note: MDROs, multidrug-resistant organisms; PICU, pediatric intensive care unit; CRAB, carbapenem-resistant *Acinetobacter baumannii*; MRSA, methicillin-resistant *Staphylococcus aureus*; CRKP, carbapenem-resistant *Klebsiella pneumoniae*; CRPA, carbapenem-resistant *Pseudomonas aeruginosa*; CREC, carbapenem-resistant *Escherichia coli*; VRE, vancomycin-resistant *Enterococcus*.

Table 6. HAI cases with MDROs in the PICU from 2015–2024.

Year	Total inpatients	CRAB		CRPA		CRKP		MRSA		CREC		VRE	
		Cases	Rate (%)	Cases	Rate (%)	Cases	Rate (%)	Cases	Rate (%)	Cases	Rate (%)	Cases	Rate (%)
2015	1982	7	0.35	1	0.05	2	0.10	2	0.10	1	0.05	0	0.00
2016	2047	7	0.34	1	0.05	6	0.29	2	0.10	0	0.00	0	0.00
2017	1877	8	0.43	4	0.21	3	0.16	6	0.32	0	0.00	0	0.00
2018	1878	9	0.48	2	0.11	2	0.11	2	0.11	4	0.21	0	0.00
2019	1855	8	0.43	2	0.11	5	0.27	1	0.05	2	0.11	0	0.00
2020	1958	2	0.10	1	0.05	1	0.05	2	0.10	0	0.00	0	0.00
2021	2250	7	0.31	1	0.04	1	0.04	2	0.09	0	0.00	0	0.00
2022	2131	2	0.09	1	0.05	1	0.05	0	0.00	0	0.00	0	0.00
2023	2324	6	0.26	2	0.09	0	0.00	2	0.09	0	0.00	0	0.00
2024	2252	8	0.36	3	0.13	6	0.27	1	0.04	0	0.00	0	0.00
Global	20,120	64	0.32	18	0.09	27	0.13	20	0.10	7	0.03	0	0.00

Note: HAI, healthcare-associated infection; MDROs, multidrug-resistant organisms; PICU, pediatric intensive care unit; CRAB, carbapenem-resistant *Acinetobacter baumannii*; MRSA, methicillin-resistant *Staphylococcus aureus*; CRKP, carbapenem-resistant *Klebsiella pneumoniae*; CRPA, carbapenem-resistant *Pseudomonas aeruginosa*; CREC, carbapenem-resistant *Escherichia coli*; VRE, vancomycin-resistant *Enterococcus*. Annual data are based on the number of hospitalizations within the year, while ten-year total data is deduplicated based on individual patients.

infections was 0.68%, with CRAB as the leading cause, followed by CRKP, MRSA, CRPA, and CREC; no VRE cases were reported. The differential trend of increased detection rates of CRAB and CRKP but decreased CREC in the PICU may be mainly attributed to differences in the survival and transmission characteristics, colonization niches, and nosocomial epidemic potential. CRAB survives persistently in the hospital environment, while CRKP relies on intestinal colonization and highly transmissible resistance plasmids. Both pathogens tend to establish persistent nosocomial bacterial reservoirs in the PICU, and their detection rates continuously increase under the selective pressure of broad-spectrum antibiotics. In comparison, CREC is mainly derived from sporadic external introductions and lacks the capability for sustained clonal dissemination within the PICU. With the implementation of antimicrobial stewardship and standardized nosocomial infection control, sporadic CREC cases have been well controlled, leading to a reduction in its detection rate.

Notably, the hospital-wide incidence of MDRO infections was significantly higher than the rate reported by Wang et al. [26] (0.08%). Of particular public health significance, CRAB and CRKP are classified as "Critical Priority" pathogens in the World Health Organization (WHO) Bacterial Priority Pathogens List 2024, posing substantial threats due to their association with increased mortality, prolonged hospitalization, and rising healthcare costs, challenges that place considerable strain on health systems globally [27]. Over the past decade, this institution has observed a statistically significant upward trend in the detection rates of both CRAB and CRKP. Moreover, infections caused by these two pathogens consistently ranked first and second in MDRO-related HAI incidence, underscoring an urgent need to strengthen and enforce comprehensive infection prevention and control strategies. Key interventions should include optimizing antimicrobial stewardship to promote the rational use of antibiotics, standardizing environmental decontamination protocols, strictly enforcing contact precautions, and implementing active surveillance screening for the early identification and containment of colonized or infected patients [28,29]. Effective control of MDRO transmission requires a multifaceted, integrated approach involving coordinated efforts among clinical microbiology laboratories, infection control teams, pharmacy services, intensive care units, and hospital administration. Only through sustained and collaborative action can healthcare facilities mitigate the growing burden of MDROs and safeguard patient safety in high-risk settings such as the PICU.

Our study reveals the HAI status of the PICU in this children's hospital over ten consecutive years, and underscores the significance of infection prevention strategies. However, the study has notable limitations. First, there is a lack of analysis on the correlation between HAI and patient characteristics, as well as critical outcomes such as mortality, prolonged PICU length of stay, and elevated healthcare costs, which could enhance clinical applicability. Second, the findings are derived from a single center, which may limit their generalizability to healthcare institutions with different patient populations or infection control practices. Third, the retrospective design restricts the potential to establish causal relationships, especially on the impact of specific interventions on HAI incidence. Although these limitations exist, this study is one of the few investigations conducted in a PICU of a children's hospital and provides valuable insights for improving infection control measures. Future research should focus on the epidemiological characteristics of HAI in PICUs, comprehensively evaluate the association between HAIs and health or economic burden, and conduct multicenter prospective studies to provide an evidence-based foundation for developing precision prevention and control strategies.

5. Conclusion

This study found that the incidence of HAI in the PICU demonstrates a continuing downward trend. The primary site of HAI is the respiratory system, and the incidence of CLABSI and VAP has shown an upward trend in recent years. Gram-negative organisms are the most frequently detected in HAI. Furthermore, the detection rates of MDROs, notably CRAB and CRKP, have persistently increased. These trends highlight the ongoing and serious challenges facing infection prevention and control. Moving forward, prevention efforts should focus on the refined management of CLABSI and VAP, while simultaneously strengthening surveillance and intervention strategies targeting MDROs. These coordinated approaches are essential to continuously reduce the risk of HAI and ensure the safety of pediatric patients.

Key Points

• Targeted surveillance of HAI in the PICU provides real-world data to identify challenges, understand HAI status and trends, and clarify infection control priorities.

• Currently, data on targeted surveillance in PICUs of children's hospitals remain relatively limited.

• The incidence of HAI has significantly decreased in the PICU of this children's hospital, indicating notable progress in infection prevention and control efforts.

• Future prevention efforts should focus on refining the management of CLABSI and VAP, while also strengthening MDRO surveillance and intervention strategies.

Availability of Data and Materials

All data included in this study are available upon reasonable request from the corresponding authors.

Author Contributions

Conceptualization, YCR and JHC; methodology, XLX; software, YCR; validation, QHH, QL and XL; formal analysis, JZ; investigation, QHH; resources, HMX; data curation, XL and HMX; writing—original draft preparation, YCR; visualization, YCR; supervision, JHC; project administration, YCR. All authors contributed to revising the manuscript critically for important intellectual content. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of Children's Hospital of Chongqing Medical University (File No: 2025-355). This project is a retrospective study utilizing medical records obtained from prior clinical practice. It imposes no unnecessary risks to subjects and was approved for waiver of informed consent with a commitment to protect patient privacy.

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Conflicts of Interest

The authors declare no conflicts of interest.

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