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Research Article

Knowledge-Practice Gap in Bloodborne Pathogen Occupational Protection Among Surgical Staff: A KAP Model-Based Study

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Abstract

Background: Bloodborne occupational exposure poses a significant threat to surgical staff due to frequent sharp instrument use and blood contact. This study assessed the knowledge, attitude, and practice (KAP) gap regarding bloodborne pathogen occupational protection among this high-risk group.

Objective: To compare exposure characteristics across surgical roles (surgeons, anesthesiologists, nurses, nursing assistants), analyze influencing factors, and propose targeted intervention strategies.

Methods: A cross-sectional study was conducted among 73 surgical staff at a tertiary hospital in Guangdong Province using an anonymous electronic questionnaire. The validated instrument assessed: 1) demographics, 2) knowledge, 3) attitudes, and 4) protective behaviors related to bloodborne pathogens. Data were analyzed using SPSS 25.0, employing t-tests, ANOVA, and χ^2 tests as appropriate.

Results: The overall knowledge correct rate was 70.60%, with significant variation across items. Surgeons and anesthesiologists scored higher (55.00 ± 6.83 and 50.83 ± 5.57 points, respectively) than nurses (52.35 ± 6.88) and nursing assistants (42.27 ± 2.61). While 90.41% expressed willingness to participate in training, the behavioral correct rate was only 52.06%. High error rates were observed for sharps injury management procedures (68.49% incorrect) and post-exposure prophylaxis principles (35.62% incorrect). Position and education level significantly influenced knowledge scores ($p < 0.01$).

Conclusion: A significant disconnect exists between acquired knowledge and protective behaviors among surgical staff. Position type and education level are key determinants of protective capacity. We propose a tiered intervention strategy: 1) High-risk roles (surgeons, anesthesiologists): complex scenario simulation training and performance assessment integration; 2) Medium/low-risk roles (nurses, nursing assistants): standardized operation modules with micro-lessons + drills, plus visual aids for assistants; 3) System-level: integrate compliance metrics into medical quality monitoring and implement role-education based certification.

Significance: This study provides evidence for developing stratified, precise interventions to optimize the bloodborne pathogen protection system for surgical teams.

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Keywords: Bloodborne Pathogens; Infection Control; Knowledge-Attitude-Practice (KAP) Model; Knowledge-Practice Gap; Occupational Exposure; Surgical Staff

Introduction

Bloodborne occupational exposure, defined as accidental percutaneous or mucocutaneous contact with pathogen-contaminated blood, body fluids, or sharps during patient care [1], remains a critical global healthcare hazard. Prevention effectiveness directly impacts both healthcare worker safety and patient care quality. China's 2009 "Guidelines for the Prevention of Occupational Exposure to Bloodborne Pathogens" established prevention standards for HIV, HBV, and HCV [2]. Surgical personnel face heightened risks due to their work environment, characterized by frequent sharp instrument use and blood exposure [3]. While research often focuses on operating room nurses and surgeons, comparative studies involving surgeons, anesthesiologists, and nursing assistants are limited. High-risk moments include suture needle injuries, surgical incision injuries, and blood/body fluid splashes [4]. Anesthesiologists are also at risk during invasive procedures like lumbar punctures [5]. Beyond health risks and increased stress [6], bloodborne exposure reduces surgical team efficiency. Enhancing surgical staff's knowledge and awareness of bloodborne pathogens is therefore crucial. However, existing studies exhibit limitations in multi-position comparisons, analysis of knowledge-behavior gaps, and development of targeted interventions. This study aims to systematically compare exposure characteristics across surgical roles, analyze multidimensional influencing factors using the KAP model, and provide evidence for developing stratified, precise protective interventions.

Methods

Study Design and Participants

A cross-sectional study was conducted at the surgical anesthesia center of a tertiary hospital in Guangdong Province. Cluster sampling enrolled all eligible on-duty staff (N=73). Inclusion criteria: 1) Direct involvement in surgical operations; 2) Employment duration ≥3 months; 3) Provision of informed consent. Exclusion criteria: 1) Trainees or standardized training personnel; 2) Questionnaires with <90% completion rate after two reminders. Based on the Krejcie & Morgan formula (95% confidence level, 5% margin of error), the minimum sample size was 66; our sample size (73) met statistical requirements.

Survey Instrument and Data Collection

Data were collected anonymously via the "Questionnaire Star" electronic platform. The questionnaire comprised four sections:

- **Demographics:** 14 items (gender, age, position, work experience, title, education, prior exposure history, exposure details).
- **Knowledge:** 13 items on bloodborne pathogen transmission, standard precautions, post-exposure management (Cronbach's α = 0.81, CVI = 0.89).
- **Attitude:** 5 items on perceived importance of protection and preventive measures.
- **Behavior:** 4 items, including scenario-based questions (e.g., "Sort steps for intraoperative needlestick injury management") validated by two infection control experts.

Quality control measures included: IP restriction (one response per IP), embedded attention checks (e.g., reverse-scored items), time thresholds (<120 s or >900 s excluded), and dual independent data cleaning (multiple imputation for missing values). The response and valid questionnaire rates were both 100%.

Statistical Analysis

Data were analyzed using SPSS 25.0. Categorical data were presented as frequencies and percentages; continuous data as mean ± Standard Deviation (SD). Group comparisons used independent samples t-tests (two groups) or one-way ANOVA (multiple groups). Categorical variables were compared using χ^2 tests or Fisher's exact test. Statistical significance was set at $p < 0.05$ (two-tailed).

Results

Participant Characteristics

All 73 distributed questionnaires were completed (100% response rate). Participants' mean age was 28.85 ± 0.81 years. Demographic and occupational exposure characteristics are detailed in Table 1.

Characteristic	Category	**n**	%
Gender	Male	34	46.6
	Female	39	53.4
Position	Anesthesiologist	12	16.4
	Surgeon	16	21.9
	Nurse	34	46.6
	Nursing Assistant	11	15.1
Work Experience	≤5 years	69	94.5
	>5 years	4	5.5
Title	None	27	37
	Junior	43	58.9
	Intermediate	2	2.7
	Associate Senior	1	1.4
Highest Education	High School and Below	8	11
	Bachelor’s Degree	37	50.7
	Master’s Degree	20	27.4
	Doctoral Degree	3	4.1
	Postdoctoral	5	6.8
Past 5-Years Exposure	Yes	32	43.8
	No	41	56.2
Exposure Method	Needlestick Injury	24	75
	Blood/Body Fluid Contact	13	40.6
	Other Sharp Injuries	13	40.6
Exposure Site	Hands/Feet	31	96.9
	Mucous Membranes (Eyes/Mouth)	5	15.6
	Broken Skin	2	6.3
Exposure Link	During Surgery	25	78.1
	Handling Waste	10	31.3
	Puncture and Injection	8	25
	Replacing Needle Cap	5	15.6
	Removing Needle	2	6.3
	Blood Drawing	1	3.1
Exposure Source	HBV	31	96.9
	Syphilis	6	18.8
	HCV	2	6.3

Table 1: Participant Demographics and Exposure History (n=73).

Knowledge of Bloodborne Pathogen Protection

The overall knowledge correct rate was 70.60%. Significant variation existed across items. While knowledge of basic risks (e.g., infection risk after positive patient sharps injury: 100% correct) was high, understanding of specific concepts like HIV exposure level grading (15.07% correct) and standard precaution components (27.40% correct) was poor. Details are presented in Table 2.

Knowledge Item	Number of Correct Answers (n)	Correct Rate (%)
Overall Correct Rate	-	70.6
Risk of HIV/HBV/HCV infection after sharps injury from positive patient	73	100
Importance of inquiring about patient infectious disease history pre-op	73	100
Standard precautions protect both staff and patients	72	98.63
Patient serological pathogen testing pre-op is important	72	98.63
Wearing double gloves for invasive procedures with hand skin damage	68	93.15
Five indications for hand hygiene	59	80.82
Correct transmission routes of bloodborne diseases	57	78.08
Implementing standard precautions for all patients	59	80.82
All patients' blood/body fluids/secretions/excretions are potentially infectious	38	52.05
Main pathogens involved in bloodborne occupational exposure	42	57.53
HIV transmission routes	26	35.62
Components of standard precautions	20	27.4
Grading levels of HIV exposure risk	11	15.07

Table 2: Knowledge Assessment Results (n=73).

Attitudes Towards Protection

Attitudes towards protection were generally positive (Table 3). Most staff recognized the value of Hepatitis B vaccination (95.89%) and reported frequently performing key protective behaviors: checking for hand skin damage before patient contact (38.36% always, 57.53% sometimes), wearing gloves during blood/body fluid contact (78.08% always), and performing hand hygiene after patient contact (71.23% always).

Attitude Item	Response	n	%
Hepatitis B vaccination reduces HBV exposure risk	Yes	70	95.89
	No	3	4.11
Checking hand skin damage before patient contact	Every time	28	38.36
	Sometimes	42	57.53
	Never	3	4.11
Wearing gloves during blood/body fluid/open wound contact	Every time	57	78.08
	Sometimes	16	21.92
	Never	0	0
Performing hand hygiene after patient contact	Every time	52	71.23
	Sometimes	21	28.77
	Never	0	0

Table 3: Attitudes Towards Protection (n=73).

Protective Behaviors

The overall correct rate for behavioral knowledge was low (52.06%). While 90.41% expressed willingness to participate in training, only 65.75% reported educating patients/families about bloodborne diseases. Error rates were high for procedural knowledge: 68.49% incorrectly identified sharps injury management steps, and 35.62% misunderstood post-exposure prophylaxis principles (Table 4).

Behavior/Knowledge Item	Option	n	%	Overall
Overall Behavioral Knowledge Correct Rate				52.06%
Willingness to participate in training	Yes	66	90.41	
	No	7	9.59	
Educating patients/families about bloodborne diseases	Yes	48	65.75	
	No	25	34.25	
Correct knowledge of sharps injury management steps	Incorrect	50	68.49	
Correct knowledge of PEP principles	Incorrect	26	35.62	

Table 4: Protective Behaviors and Behavioral Knowledge (n=73).

Factors Influencing Knowledge Scores

Position and education level significantly influenced knowledge scores ($p < 0.01$). Surgeons scored highest (55.00 ± 6.83), followed by nurses (52.35 ± 6.88), anesthesiologists (50.83 ± 5.57), and nursing assistants (42.27 ± 2.61). Doctoral degree holders scored highest (61.67 ± 12.58), while those with high school education or below scored lowest (42.50 ± 2.67). Age and title also showed significant associations ($p < 0.05$). Gender, work experience, vaccination status, teaching activity, training frequency, and prior exposure history did not significantly affect scores (Table 5).

Characteristic	Category	Number of Cases	Score ($\bar{x}$±s, Points)	p-value
Gender	Male	34	52.50±6.99	0.145
	Female	39	50.00±7.43	
Age	≤30 years	60	51.75±6.37	**0.012**
	>30 years	13	48.46±10.49	
Work Experience	≤5 years	69	51.01±7.41	0.469
	>5 years	4	53.75±4.79	
Position	Anesthesiologist	12	50.83±5.57	**0.008**
	Surgeon	16	55.00±6.83	
	Nurse	35	52.35±6.88	
	Nursing Assistant	10	42.27±2.61	
Title	Junior	43	53.02±7.49	**0.012**
	None	26	47.96±6.09	
	Intermediate	2	55.00±7.07	
	Associate Senior	1	50	
Highest Education	Doctoral	3	61.67±12.58	**0.001**
	Postdoctoral	5	55.00±5.00	
	Master’s	20	51.50±4.89	
	Bachelor’s	37	51.49±7.25	
	High School/Below	8	42.50±2.67	
Hepatitis B Vaccination	Yes	70	51.21±7.39	0.78
	No	3	50.00±5.00	
Past 5-yr Teaching	Yes	10	51.50±3.37	0.877
	No	63	51.11±7.75	

Training Frequency	≥2 times/year	37	50.27±7.81	0.286
	<2 times/year	36	52.08±6.69	
Past 5-yr Exposure	No	41	50.00±7.75	0.123
	Yes	32	52.66±6.47	

Significant values: Bolded; $p < 0.05$, $p < 0.01$ (two-tailed). Assoc. = Associate; HS = High School.

Table 5: Factors Associated with Knowledge Scores.

Discussion

This KAP-model study identified a significant gap between knowledge acquisition and protective behaviors among surgical staff concerning bloodborne pathogen exposure. While the overall knowledge correct rate (70.60%) reflected adequate theoretical understanding, critical deficiencies emerged in applied knowledge (e.g., HIV exposure grading: 15.07% correct, standard precaution components: 27.40% correct) and procedural knowledge (sharps injury management: 68.49% incorrect, PEP principles: 35.62% incorrect) [7-12]. This disconnect is consistent with findings by Lee et al. [13], highlighting that theoretical knowledge alone does not guarantee safe practices, particularly in high-pressure surgical scenarios. The predominance of passive lecture-based training likely contributes to this gap, failing to adequately prepare staff for translating knowledge into action during emergencies [14]. Simulation training, drills, and scenario-based learning are demonstrably more effective for building high-risk response capabilities [14]. Position and education level were key determinants of knowledge scores ($p < 0.01$). Surgeons scored highest (55.00 ± 6.83), reflecting the direct impact of high-risk tasks on systematic learning. However, scores among anesthesiologists (50.83 ± 5.57) and nurses (52.35 ± 6.88) indicated persistent challenges in complex scenario management, suggesting current training may overlook position-specific needs (e.g., needle handling post-anesthesia puncture). Nursing assistants constituted the most vulnerable group (42.27 ± 2.61), linked to lower education levels (11.00% high school or below) and lack of targeted training. Crucially, 31.30% of reported exposures occurred during waste handling – a primary responsibility for assistants. Their higher rates of delayed exposure reporting likely stem from inadequate emergency knowledge and complex reporting procedures, aligning with WHO concerns regarding non-medical technical staff protection [15-17].

To address these findings, we propose a tiered intervention strategy based on position-specific risk profiles and competency needs:

- **High-Risk Positions (Surgeons, Anesthesiologists):** Implement advanced complex scenario simulation training (e.g., intraoperative hemorrhage control, non-contact sharps transfer techniques). Integrate "standardization of intraoperative sharps handling" into performance evaluations to reinforce behavioral compliance.
- **Medium/Low-Risk Positions (Nurses, Nursing Assistants)**: Develop standardized operational modules (e.g., waste segregation protocols, PPE donning/doffing). Utilize a hybrid "micro-lessons + situational drills" teaching model. For nursing assistants, augment training with visual operation guides (e.g., pictograms in waste areas) and regular skills competitions to enhance engagement and compliance.
- **System-Level Safeguards**: Integrate key metrics ("sharps injury management compliance rate," "post-exposure reporting timeliness") into medical quality sensitive indicator monitoring. Establish a dual-track competency assessment based on position and education level, mandating protection knowledge certification for non-clinical personnel before duty commencement. Studies support that stratified training improves protection awareness and reduces exposure risk [18].

Limitations

This study has limitations. The sample was drawn from a single tertiary hospital in Guangzhou, limiting regional generalizability. Trainees and standardized training personnel were excluded, creating a gap in understanding this subgroup. While efficient, the self-reported survey design carries inherent risk of social desirability and recall bias. Future multi-center studies encompassing diverse hospital levels and incorporating mixed methods (e.g., surveys, interviews, direct observation) are recommended to deepen understanding of the knowledge-behavior gap causes and intervention effectiveness.

Conclusion

This study confirms a significant knowledge-practice gap in bloodborne pathogen protection among surgical staff, driven primarily by position type and education level. Passive knowledge acquisition is insufficient for ensuring safe practices in high-risk surgical environments. Our findings underscore the urgent need for stratified, competency-based training interventions that move beyond theory to emphasize simulation, procedural drills, and position-specific scenarios. Integrating compliance monitoring into quality systems and ensuring competency certification, especially for support staff, are critical system-level enhancements. Implementing the proposed tiered strategy holds promise for reducing occupational exposure risk and optimizing protection for the entire surgical team.

Conflicts of Interest: The authors declare no conflict of interest.

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Ethical Approval: This study was exempted from ethical review by the Institutional Review Board of The First Affiliated Hospital of Sun Yat-sen University . As it met the exemption criteria, informed consent requirements were waived in accordance with relevant regulations.

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