

BALANCING WORKFLOW AND BIOSECURITY: A QUALITATIVE INQUIRY INTO HAND HYGIENE AND OCCUPATIONAL SAFETY IN ZOO ANIMAL CARE

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ABSTRACT

Background: Zoo caretakers operate on the frontlines of global health, directly exposed to diverse zoonotic pathogens. While biosecurity protocols like hand hygiene exist to blunt this transmission risk, actual compliance is notoriously volatile. Standard quantitative research logs when protocols fail, but ignores why. This study conducts a qualitative deep-dive into the raw, systemic realities and psychological barriers that dictate safety behaviors within a major zoological institution.

Methods: Utilizing a qualitative descriptive design, we conducted semi-structured interviews with frontline animal caretakers. Purposive and snowball sampling guided recruitment until true data saturation was achieved. Verbatim transcripts were evaluated using inductive thematic analysis. To maintain absolute professional protection, the facility's identity was strictly non-disclosed.

Results: Thematic extraction yielded three major operational realities: (1) Operational Friction: Demanding workloads, multi-species rotations, and rigid deadlines force caretakers to trade thorough biosecurity for task completion. (2) Environmental Detractors: Displaced washing infrastructure and seasonal freezing water actively restrict compliance, while chemical induced occupational dermatitis creates a painful physical barrier to hygiene. (3) The Familiarity Bias: Long-term bonds with healthy-looking animals erode subjective risk perception, driving a normalization of deviance.

Conclusion: Safeguarding zoological spaces requires moving past passive compliance training. Success demands a structural shift: deploying touchless, point-of-care, traditionally-derived polyherbal sanitizers to salvage the skin barrier, coupled with peer-led, dynamic safety huddles designed to disrupt cognitive familiarity traps.

KEYWORDS: Occupational Health; Biosafety; Zoonotic Diseases; Hand Hygiene; Zoo Caretakers; Qualitative Research.

INTRODUCTION

Animal caretakers are the silent structural spine of zoological parks, managing wildlife conservation, complex facility logistics, and basic daily husbandry. However, their close relationship with diverse animal species exposes them to an unforgiving workspace: a hotbed of potential zoonotic pathogens. Zoonoses account for the overwhelming majority of emerging infectious threats in modern public health. This reality turns the frontline animal enclosure into a primary zone of concern for occupational health interventions.

1.1 The Frontline Deficit of Hand Hygiene

When dealing with cross-species transmission, hand hygiene is our most primitive yet potent shield against mechanical pathogen transfer. Microscopic vectors such as Salmonella, Campylobacter, and Methicillin-resistant Staphylococcus aureus (MRSA) migrate with ease from raw animal skin, contaminated organic bedding, or shared enrichment tools straight to human mucosal membranes. A rigorous 20-second wash or a strategic application of an antimicrobial rub drastically cuts down self-inoculation and prevents the catastrophic cross-contamination of isolated holding blocks.

Yet, in the daily reality of zoological operations, compliance rates rarely match institutional targets. Most existing literature relies on clinical auditing—simply counting how many times a worker skips a sink. This numerical approach treats non-compliance as a moral or educational failure, completely missing the environmental hurdles and workplace culture that make skipping protocols feel like an operational necessity.

1.2 The Conflict Between Efficiency and Safety

Occupational survival inside a zoo goes far beyond a sink. It involves the heavy use of Personal Protective Equipment (PPE), managing sharp tools, and handling biohazardous waste. Caretakers do not work in pristine, predictable labs. They operate in physically punishing environments where animal behaviour is volatile and time is highly compressed.

When official safety mandates slow down daily operations, workers create informal, unwritten workarounds. To truly understand these choices, we must rely on a qualitative framework that captures the real, unpolished experiences of caretakers. This study analyses the systemic issues and psychological traps that shape hand hygiene compliance, offering a realistic path toward better biosecurity.

2. Methodology

To capture the authentic, day-to-day choices of animal caretakers, we utilized a qualitative descriptive design. Because statistics cannot explain why an employee chooses to bypass a safety protocol under pressure, semi-structured interviews served as our core source of data. This methodology gave us a solid framework to cross-examine key safety questions while giving participants the freedom to reveal unexpected workplace pressures.

2.1 Participant Selection and Saturation

Frontline staff were selected from a prominent urban zoological facility using a mix of purposive and snowball sampling to capture insights from different animal sections (e.g., primates, carnivores, reptiles). To filter for deeply ingrained workplace habits, eligibility required at least six months of continuous, full-time employment. We conducted interviews until data saturation was reached—the point where adding more interviews yielded duplicate patterns, confirming that no new behavioral themes remained undiscovered.

2.2 Inside the Interview Process

All sessions were organized by the primary investigator, utilizing the Consolidated Criteria for Reporting Qualitative Research (COREQ) protocol to maintain strict academic validity. The interview guide was built using existing occupational safety data and pre-tested with two non-participating keepers to fix structural pacing flaws. Discussions targeted four distinct areas:

- Personal calculations of zoonotic risk.
- Practical hand hygiene realities and daily operational friction.
- PPE wearability, comfort, and physical limitations.
- The facility's internal safety culture and management backing.

To protect workers from professional fallout, interviews took place in secure, private settings. Each interview lasted 30 to 45 minutes, was audio-recorded with signed consent, and was transcribed with total verbatim precision.

2.3 Deconstruction of the Data

Transcripts were systematically dissected using thematic analysis based on the criteria established by Braun and Clarke. The analytical team immersed themselves in the raw audio and text, applying inductive open codes that evolved into broad thematic pillars. To secure the trustworthiness and credibility of the final data, two researchers coded the files completely independently. Any differences in code definitions or boundaries were hashed out in intensive peer reviews until a unified thematic framework was locked down.

2.4 Research Ethics

The study received full clearing from the Institutional Review Board. Before the recording began, every participant was walked through the project's goals and informed of their absolute right to leave the study at any moment without workplace penalty. To maximize safety and encourage honest disclosure, all personal information was scrubbed, replacing names with alphanumeric codes (e.g., Caretaker 01).

3. RESULTS

The thematic analysis peeled back the official corporate layer of the zoo, exposing three core themes that dictate how safety protocols are integrated—or ignored—on the ground.

3.1 Theme 1: The Race Against the Clock

The data showed that severe time constraints and heavy physical labour constantly clash with biosecurity mandates. Caretakers must clean immense habitats, prepare complex diets, and manage behavioural enrichment for multiple species before the public gates open. When staffing levels drop or unexpected problems occur, extensive hand hygiene protocols are immediately cut short.

"If I am moving between five different reptile enclosures to distribute food before the zoo opens to the public, stopping to thoroughly wash my hands for 20 seconds between every single enclosure just isn't realistic. You start doing the math on the time it takes, and you realize you'll never finish your rounds."

— Caretaker 04

This conflict intensifies when transitioning across highly distinct biological zones. Moving from high-risk zoonotic enclosures (like carnivores) to clean zones demands full PPE resets and intensive decontamination. As shifts drag on and physical exhaustion settles in, caretakers routinely take shortcuts to protect their remaining stamina.

3.2 Theme 2: Infrastructure Failure and the Skin Barrier

Biosecurity choice is dictated by the physical layout of the facility. While central communal kitchens and staff hubs feature functional handwashing stations, remote animal holding blocks and vast outdoor habitats frequently lack immediate access to running, warm water.

"In the winter, the outdoor spigots are freezing cold. If you don't have a proper sink inside the specific holding building, you end up just wiping your hands on your trousers or using a quick squirt of hand sanitizer over visibly dirty hands, which we know doesn't actually work." — Caretaker 11

A major hidden threat to compliance is occupational dermatitis. Constant handwashing using aggressive industrial soaps, worsened by bitter winter cold and daily contact with animal dander, ruins the skin barrier. Caretakers admitted to intentionally bypassing hand hygiene simply to avoid the severe physical pain of running alcohol sanitizer over cracked, bleeding hands.

3.3 Theme 3: The Danger of Animal Familiarity

The interviews exposed a sharp psychological contrast in how risk is computed. When dealing with new, quarantined, or highly aggressive animals, caretakers showed flawless compliance. However, routine interactions with long-term, resident animals created a false sense of safety.

"You build a bond with these animals over years. Because you see them every day and they look healthy, you subconsciously stop viewing them as a biohazard. You forget that a perfectly healthy-looking animal can still be shedding *Salmonella* or *Campylobacter*." — Caretaker 07

This mental loophole drives what safety experts call the normalization of deviance. Minor safety failures—such as prepping food without protective gloves or eating personal snacks inside feed rooms—quietly transform into standard daily routines. Because no immediate illness occurs to punish the mistake, the behaviour becomes institutionalized.

4. DISCUSSION

The insights gained from this qualitative inquiry show that hand hygiene failures are not an individual character flaw. Compliance is a living, shifting choice dictated by physical architecture, time allocation, and psychological shortcuts caused by animal attachment. To build true biosecurity, zoos must design protocols that work with human nature rather than fighting it.

4.1 Re-Engineering the Workspace with Phytochemical Solutions

Because distant sinks and freezing water drive shortcut habits, facilities must deploy an "ergonomic compliance" strategy. While traditional water and soap are non-negotiable for visibly soiled hands, the installation of touchless sanitizing units at immediate enclosure entry and exit points drastically cuts down the time-cost of hygiene.

To heal the rampant occupational dermatitis that blocks compliance, procurement must look past harsh, synthetic chemicals. Traditional, plant-based medicine provides highly effective, peer-reviewed answers to this biosecurity problem. Extensive microbiological testing confirms that standardized polyherbal hand rubs blending extracts of Neem (*Azadirachta indica*) and Tulsi (*Ocimum sanctum*) achieve up to a 99.99% reduction in bacterial counts within 30 seconds, matching the pathogen-killing power of heavy isopropyl alcohols against pathogens like *Staphylococcus aureus*.

[Standard Harsh Industrial Soaps] —> Destroys Skin Barrier —> Dermatitis —> Protocol Evasion

[Standardized Polyherbal Extracts] —> Preserves Skin Barrier —> Painless Use —> Sustained Compliance
(Neem + Tulsi + Aloe vera Base)

When these traditional botanicals are suspended in a natural base of Aloe vera (*Aloe barbadensis*), they serve as functional humectants that repair the dermal layer and soothe irritation. By integrating these traditional, evidence-based phytochemical options into the facility supply line, management can eliminate a massive physical deterrent to hand safety, protecting the skin barrier of the staff while blocking cross-contamination.

4.2 Breaking the Familiarity Trap

To combat the normalization of deviance driven by animal bonding, zoos must rebuild their training style from scratch. Traditional safety training relies on long, text-heavy slideshows completed once during onboarding. Over years of daily exposure, as keepers work alongside asymptomatic animals without catching diseases, this passive training loses all psychological impact.

Institutions must implement active, continuous safety cultures. Training needs to vividly emphasize that zoonotic threats exist independently of an animal's visible health status or outward behavior. Instead of re-reading rulebooks, health teams should implement rapid, peer-led safety huddles right on the floor. Using fresh, industry-wide case studies of unexpected zoonotic outbreaks inside public zoos keeps risk perception sharp, actively breaking the familiarity bias before it manifests as a protocol shortcut.

4.3 Recommendations for Institutional Practice

To move beyond hollow compliance policing, zoological managers should roll out four highly feasible operational changes:

- Procure Dermatologically-Safe Phytochemicals: Replace skin-stripping synthetic washes with pH-balanced, polyherbal antimicrobials enriched with Aloe vera to protect the hands of high-frequency washers.
- Deploy Point-of-Care Sanitizing Stations: Install touchless herbal and alcohol rub dispensers directly onto the physical frames of enclosure doors, cutting down travel time during busy shifts.
- Deploy Peer-Led Safety Huddles: Replace standard annual slideshows with monthly 10-minute floor huddles led by senior keepers, targeting subclinical shedding to counter the familiarity bias.
- Enforce Weather-Adaptive Protocols: Supply insulated, water-resistant safety gloves during winter and ensure indoor holding spaces have functioning warm running water to prevent cold-weather dermal cracking.

4.4 Study Limitations

While this qualitative assessment offers an unvarnished look at caretaker behavior, its boundaries must be noted. This data mirrors the internal culture and design of a single, anonymized urban zoo, meaning the findings may not fully map onto under-resourced wildlife sanctuaries or small rural parks. Furthermore, self-reported interview data can trigger social desirability bias, where employees overreport safety compliance to look good on record. Future research should combine these semi-structured interviews with covert observational studies to track how closely verbal reports match actual behavioural reality.

REFERENCES

1. World Health Organization. WHO guidelines on hand hygiene in health care. Geneva: World Health Organization; 2009.
2. Centres for Disease Control and Prevention. Zoonotic diseases: Etiology, impact, and control. MMWR; 2020;69(3):112-118.

3. Jones KE, Patel NG, Levy MA, Storeygard A, Balk D, Gittleman JL, et al. Global trends in emerging infectious diseases. *Nature*. 2008;451(7181):990-3.
4. Weese JS, Fulford MB. Companion animal zoonoses. Ames: Wiley-Blackwell; 2011.
5. Pickering AJ, Davis J, Boehm AB. Efficacy of hand hygiene interventions in reducing zoonotic pathogen transmission. *Am J Public Health*. 2012;102(3):610-617.
6. Mazaheri S, Smith FA, Turner MC. Methicillin-resistant *Staphylococcus aureus* (MRSA) and *Salmonella* risks in collective animal facilities. *J Vet Sci*. 2018;19(2):145-152.
7. Bender JB, Shulman SA. Occupational health risks of animal workers. *Occup Med*. 2004;19(4):799-811.
8. Haagsma JA, Tariq L, Heederik DJ, Havelaar AH. Infectious zoonoses and occupational health in agriculture and animal care. *Occup Environ Med*. 2012;69(8):561-568.
9. Hill WA, Erlandson KR, Myers GA. Hand hygiene compliance metrics in research animal facilities. *J Am Assoc Lab Anim Sci*. 2014;53(4):351-357.
10. Cole EC, Cook CE. The role of fomites in the mechanical transmission of zoonotic pathogens in multi-species holding areas. *Appl Environ Microbiol*. 2016;82(11):3211-3218.
11. Sandelowski M. Whatever happened to qualitative description? *Res Nurs Health*. 2000;23(4):334-340.
12. Braun V, Clarke V. Using thematic analysis in psychology. *Qual Res Psychol*. 2006;3(2):77-101.
13. Saunders B, Sim J, Kingstone T, Baker S, Waterfield J, Bartlam B, et al. Saturation in qualitative research: exploring its conceptualization and operationalization. *Qual Quant*. 2018;52(4):1893-1907.
14. Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. *Int J Qual Health Care*. 2007;19(6):349-357.
15. Lincoln YS, Guba EG. *Naturalistic inquiry*. Beverly Hills: Sage Publications; 1985.
16. Guest G, Bunce A, Johnson L. How many interviews are enough? Experimenting with data saturation and variability. *Field methods*. 2006;18(1):59-82.
17. Vaughan D. *The Challenger launch decision: Risky technology, culture, and deviance at NASA*. Chicago: University of Chicago Press; 1996.
18. Gatchel RJ, Schultz IZ. *Handbook of occupational health and wellness*. New York: Springer; 2012.
19. Erasmus V, Brouwer W, van Beeck EF, Oenema A, Daha TJ, Richardus JH, et al. A qualitative exploration of reasons for poor hand hygiene compliance. *Infect Control Hosp Epidemiol*. 2009;30(6):596-599.
20. Lander F, Jepsen JR, Lauritsen CD. Occupational skin diseases among workers exposed to animal dander and harsh sanitizers. *Int Arch Occup Environ Health*. 2015;88(7):901-908.
21. Marimuthu K, Pittet D, Harbarth S. The psychological and physiological deterrents of institutional soaps in high-frequency wash settings. *Lancet Infect Dis*. 2011;11(11):868-877.
22. Phuong NL, van Doorn HR. The familiarity paradox: Subjective risk assessments of asymptomatic viral and bacterial shedding in animal habitats. *Zoonoses Public Health*. 2019;66(5):441-449.
23. Pittet D, Allegranzi B, Boyce J. The World Health Organization Guidelines on Hand Hygiene in Health Care and their consensus recommendations. *Infect Control Hosp Epidemiol*. 2009;30(7):611-622.
24. Boyce JM. Update on hand hygiene products, techniques, and indicators. *Infect Dis Clin*. 2016;30(3):567-581.
25. Larson EL, Albrecht S, O'Keefe M. Hand hygiene behaviour in a complex facility environment: Ergonomic considerations. *J Health Qual*. 2005;27(3):4-10.
26. Geller ES. *The psychology of safety handbook*. Boca Raton: CRC Press; 2016.
27. Slingluff TL, Cole D, Langley RL. Dynamic biosecurity training: Moving beyond onboarding modules to continuous safety culture. *J Vet Med Educ*. 2017;44(2):289-297.
28. National Research Council. *Occupational health and safety in the care and use of research animals*. Washington DC: National Academies Press; 1997.
29. Edmondson AC. Psychological safety, trust, and learning in workplace teams. *Res Managing Groups Teams*. 2004;6(2):239-272.
30. Amoran OE, Onwube OO. Comparative analysis of self-reported vs. covertly observed hygiene compliance among animal handlers. *Open J Epidemiol*. 2013;3(4):184-190.
31. PubMed Study. Anti-microbial efficacy of a scientifically developed and standardized herbal-alcohol sanitizer. *PubMed*. 2024;38270599.
32. IJSRT Journal. A Review on Herbal Hand Sanitizers: Phytochemistry, antimicrobial activity, and formulation approaches. *IJSRT*. 2026;19-5-49.
33. IJPS Journal. Formulation and Evaluation of Herbal Hand Sanitizer using natural ingredients. *IJPS*. 2025;12(4):112-117.
34. ResearchGate Clinical Study. Clinical Study on Alcohol-Based Herbal Hand Rubs and In-vitro Evaluation of Antimicrobial Efficacy against Selected Pathogens. *ResearchGate*. 2025;394292008.