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Knowledge and Attitudes Regarding Medical Sharps Handling Among Healthcare Workers in Namibia: Findings from a Cross-Sectional Survey

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ABSTRACT

Background: Healthcare workers face significant occupational risks from needlestick and sharps injuries, which can lead to transmission of blood-borne pathogens, including HIV, HBV, and HCV. Namibia carries a high burden of HIV, which heightens the practical stakes of occupational exposure among healthcare workers. The objective of this study was to evaluate the knowledge and attitudes regarding the handling of medical sharps among healthcare workers at Intermediate Hospital Oshakati, Namibia. Methods: A cross-sectional study was conducted in 2019–2020 using purposive sampling from eight high-risk departments. A sample of 490 healthcare workers (134 doctors and 356 nurses) completed a self-administered questionnaire, deliberately exceeding the calculated minimum of 342 to strengthen detection of true associations. Data were analysed using EPINFO 7.2 and SPSS version 25. Crude and adjusted odds ratios with 95% confidence intervals were calculated comparing doctors and nurses, adjusting for age, marital status, gender, and education level. Results: Doctors showed a mixed knowledge profile relative to nurses rather than uniformly poorer knowledge. Doctors were more likely to correctly affirm that sharps injuries may result in HCV transmission (AOR = 2.23, 95% CI: 1.24–3.99), indicating comparatively stronger awareness of HCV risk on this item, but were also more likely to answer "don't know" to the same question (AOR = 3.94, 95% CI: 1.19–13.05), a genuine gap reflecting uncertainty. Regarding CDC recommendations, doctors were more likely to disagree (AOR = 2.11, 95% CI: 1.11–4.01) or not know (AOR = 2.57, 95% CI: 1.61–4.09) that "milking out" blood after a sharps injury is not recommended. Doctors were also less likely to know that the affected area should be rinsed with soap and water (AOR = 0.14, 95% CI: 0.04–0.48). For sharps injury reporting, doctors were more likely to cite ignorance of reporting procedures (AOR = 2.05, 95% CI: 1.27–3.30) and fear of confidentiality (AOR = 2.00, 95% CI: 1.27–3.15) as reasons for not reporting. Doctors were significantly less likely than nurses to return to check Hepatitis B antibody levels for booster need (AOR = 0.32, 95% CI: 0.20–0.50) and more likely not to know their Hepatitis B status (AOR = 4.98, 95% CI: 1.37–18.08). Conclusion: Knowledge gaps and suboptimal attitudes toward medical sharps handling were evident, particularly among doctors, most consistently in post-exposure first-aid knowledge, Hepatitis B follow-up, and reporting-related barriers rather than in basic pathogen-transmission awareness. Findings indicate a need for targeted educational interventions, clear reporting protocols, and improved awareness of post-exposure management guidelines. Limitations include the single-site, cross-sectional design, which precludes causal inference and limits generalizability beyond this facility.

Keywords: Knowledge, Attitudes, Medical Sharps, Healthcare workers, Blood-Borne Viruses, Namibia.

1. Introduction

A thorough understanding of safe practices while handling needles and sharps is crucial for healthcare workers (HCWs) to create a risk-free workplace environment. Percutaneous exposures to blood and body fluids through contaminated needlesticks and sharps represent important occupational hazards for morbidity and mortality from blood-borne infections (Rosiek et al., 2016). Needlesticks and other sharps injuries (NSIs) pose a considerable risk for transmission of

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more than 20 kinds of blood-borne pathogens, including hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV) (NIOSH, 2011). Namibia carries one of the highest adult HIV prevalence rates in the world, which substantially raises the practical stakes of occupational blood exposure for its healthcare workforce and provides important local context for the findings reported here.

The World Health Organization has historically estimated that exposure to sharps in the workplace accounts for 40% of HBV and HCV infections and 2.5% of HIV infections among healthcare workers globally (WHO, 2003; De Carli et al., 2021); these remain the most widely cited global estimates but are now over two decades old. More recent evidence suggests that over two million NSIs occur annually among HCWs globally, resulting in approximately 66,000 HBV, 16,000 HCV, and 1,000 HIV infections each year (Dosh et al., 2024).

In Namibia, the National Health Strategy prioritized education and training, development of Standard of Practice, and enforcement for safe sharps handling (MoHSS, 2006). The National Strategic Plan for Hepatitis (2019-2022) further emphasised strengthening infection prevention and control practices, including safe sharps handling and disposal, and providing post-exposure prophylaxis to health workers (MoHSS, 2019). However, reliable data concerning occupational exposure in Namibia remain limited, and systems addressing these challenges remain poorly defined. Moreover, HCWs' knowledge and attitudes toward this problem are largely unexplored. This study asks whether, and how, knowledge and attitudes regarding sharps handling and post-exposure management differ between doctors and nurses at a Namibian referral hospital, and aimed to evaluate this among healthcare workers at Intermediate Hospital Oshakati, Namibia.

2. Literature Review

2.1 Regional and Global Perspective on Sharps Injuries Knowledge

Within sub-Saharan Africa, needle stick injuries among nurses have been documented as a persistent occupational hazard, with contributing factors including inadequate staffing, limited protective equipment, and inconsistent training (Nsubuga & Jaakkola, 2005). Namibia's Ministry

of Health and Social Services has prioritised sharps safety in national policy (MoHSS, 2006; MoHSS, 2019), but published data on staff-to-patient ratios, safety-engineered device coverage, and training-programme reach specific to Namibian facilities remain absent from the literature; this study cannot fill that infrastructure-data gap but flags it as a priority for future health-systems research.

Healthcare workers are exposed to blood and body fluids through occupational accidents resulting from percutaneous injury, mucocutaneous injury, or blood contact with damaged skin (WHO, 2002). About twenty blood-borne pathogens can be transmitted through accidental needlestick and sharps injuries, with HIV, HBV, and HCV being of greatest concern due to their serious consequences, including long-term illness, disability, and death (Hasak et al., 2018).

Research findings on needlestick injury prevalence vary widely across settings and study populations, from 21% to 95%, including the UK (37%), Nepal (73%), and Nigeria (86%) (Hanafi et al., 2011; Halwani et al., 2015; Musa et al., 2015); disaggregated by region, sub-Saharan African studies cluster toward the higher end of this range, while high-income-country studies cluster toward the lower end, reflecting differences in surveillance systems, staffing, and safety-device access rather than a single comparable global rate. In developing countries where HIV prevalence is highest, the number of needlestick injuries is also elevated, with African HCWs suffering an average of two to four needlestick injuries per year (Adejumo & Olatunji, 2013). Recent studies from sub-Saharan Africa continue to document high prevalence rates, with Ethiopian studies reporting rates between 37% and 41% (Bekele et al., 2015; Bekele et al., 2024).

2.2 Knowledge Levels Among Healthcare Workers

Studies have revealed significant variations in knowledge across different HCW categories. A study conducted in India demonstrated significant differences in mean knowledge scores among healthcare workers (Bhargava et al., 2013). Good knowledge of HIV, HBV, and HCV transmission was documented in Pakistan (Kumar et al., 2012) and Sudan (Abdelbagi et al., 2025), and high rates of infection control knowledge were found in Indonesia (Duerink et al., 2013). However, a

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lack of knowledge regarding the transmission of other pathogens through NSIs has been reported (Kumar et al., 2012).

2.3 Attitudes Toward Sharps Injury Prevention

Underreporting of injuries remains a critical issue even in developed countries, with mean underreporting rates varying from 22% to 75% (Elmiyeh et al., 2004; Koh, 2010). Studies in Serbia and the Philippines found that less than half of HCWs reported accidents to responsible authorities (Markovic-Denic et al., 2015; Tayaben, 2015). Reasons for underreporting include forgetting the incident, underestimating risk, inconvenient reporting procedures, reluctance to admit suboptimal knowledge, fear of positive serological test results, and workload pressure (Shiva et al., 2011; Schmid et al., 2007); this pattern of reasons recurs throughout the literature and is not repeated at length elsewhere in this manuscript.

2.4 Conceptual Framework: Hierarchy of Control Theory

This study is guided by the Hierarchy of Control Theory (HCT), developed by the Industrial Hygiene Community. The theory establishes a priority order for hazard and risk controls according to their effectiveness (Levy & Wegman, 2000). Four levels of control are relevant to sharps-injury prevention: engineering controls (altering the environment or processes, such as safety-engineered devices and needleless systems), administrative controls (training, staffing and workload policy, and reporting systems), work-practice controls (behavioural compliance with safe procedures and correct post-exposure first aid), and personal protective equipment (Queensland Health, 2025; EU Directive, 2010; CDC, 2024).

This framework is used as the organising structure for the Discussion (Section 5.7) and the Recommendations (Section 6) below, rather than as a citation confined to this subsection: findings on post-exposure first-aid knowledge are mapped to work-practice controls, training and antibody-monitoring gaps are mapped to administrative controls, and reporting-system weaknesses are mapped to administrative and work-practice controls jointly, with recommendations ordered accordingly from the highest to the lowest level of control.

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3. Methodology

3.1 Study Design and Setting

A cross-sectional study was conducted in 2019–2020 at Intermediate Hospital Oshakati, an 884-bed referral hospital in northern Namibia serving as both an intermediate and national referral facility. The hospital serves a broad catchment population across the Oshana region and neighbouring areas.

3.2 Study Population and Sampling

The study population comprised healthcare workers (doctors and nurses) currently employed at the hospital who handled sharps, drawn from a total pool of 950 doctors and nurses per the hospital's staff register. Purposive sampling was used to select participants from high-risk areas, including the Operating Theatre, Intensive Care Unit, Outpatients Department, Surgical Wards, Medical Wards, Paediatric Ward, Obstetrics and Gynaecology, and Emergency departments. This sampling approach was chosen deliberately to capture the population with the highest sharps exposure and restricts generalizability of the findings to the full hospital workforce, including administrative, laboratory-only, and non-clinical staff outside the sampling frame; this is discussed further in Section 5.8.

3.3 Sample Size

A minimum sample size of 342 was calculated using EPINFO STATCAL version 7.2, based on a 95% confidence level, a 5% margin of error, an expected prevalence of 50%, and a 25% contingency for non-response, loss to follow-up, and data loss in multivariate analysis. A total of 490 participants (134 doctors, 356 nurses) were deliberately included in the final study, exceeding this minimum, to strengthen the ability to detect statistically significant associations where they existed. A precise count of staff approached versus enrolled, and therefore a formal response rate, was not recorded in the underlying project records.

3.4 Inclusion Criteria

Doctors and nurses aged 20-60 years, working in defined departments for at least one year, directly involved with sharps use, willing to participate, and able to read and write English.

3.5 Exclusion Criteria

Healthcare workers who refused consent, safety committee members (to avoid bias), those not handling sharps, absent during data collection, non-clinical staff, students, and persons planning migration.

3.6 Data Collection

A pre-tested self-administered questionnaire with closed-ended questions was used. Part A collected demographic data, job category, work duration, and Hepatitis B status. Part B (Knowledge section) assessed understanding of sharps injury epidemiology, pathogen transmission, reporting, and post-exposure management. Part B (Attitude section) used a five-point Likert scale to assess perceptions of transmission risks, PEP initiation, and historical knowledge; the historical-knowledge item (belief regarding the year of the first reported HIV seroconversion, 1984) was included as a proxy indicator of general HIV literacy and exposure to historical infection-control training content. Its direct relevance to current clinical decision-making is limited, and future iterations of this instrument may substitute a more clinically actionable item. Two trained research assistants distributed questionnaires, with COVID-19 protocols observed during the final stage of data collection.

3.7 Validity and Reliability

The questionnaire was piloted on 10 HCWs at a district hospital 30 minutes away, chosen to avoid influencing potential study participants. Participants who consented completed the same questionnaire again after 5 days for test-retest purposes, and Cronbach's alpha was used to assess the consistency of responses between administrations; a specific alpha coefficient was not recorded in the underlying project records, and this is noted transparently as a limitation in Section 5.8. Based on pilot feedback, one combined attitude question was separated into two items and the

sharps-frequency question was restructured before the main data-collection round. Content validity was tested against research objectives and compared with validated instruments from the literature.

3.8 Data Analysis

Data were cleaned, coded, and analysed using EPINFO 7.2 and SPSS version 25. Descriptive statistics (frequencies, percentages) were calculated. Crude odds ratios (OR) were calculated using EPINFO 7.2, while adjusted odds ratios (AOR) were calculated using multivariate logistic regression in SPSS, adjusting for age, marital status, gender, and education level. Statistical significance was set at $p < 0.05$ with 95% confidence intervals. Education level is highly correlated with professional category in this sample, since doctors are university-trained by definition; adjusting for education alongside occupation may therefore attenuate genuine occupation-linked effects toward the null. Education was retained in the adjustment set for consistency with the pre-specified, paper-wide covariate list and with the companion analysis of sharps-handling practices conducted on the same dataset, but this is flagged here, and revisited in Section 5.6, as a potential source of over-adjustment. Formal collinearity diagnostics (variance inflation factors) and goodness-of-fit testing were not part of the original analysis; this is noted as a limitation in Section 5.8.

3.9 Ethical Considerations

Approval was obtained from the University of Johannesburg Faculty of Health Sciences Research Ethics Committee (REC-494-2020) and the Namibian Ministry of Health and Social Services. Written informed consent was obtained from all participants. Anonymity and confidentiality were maintained throughout. As an observational cross-sectional questionnaire study rather than a clinical trial, this study was not prospectively registered with a clinical trial registry, consistent with ICMJE guidance that registration requirements apply to clinical trials.

4. Results

All associations reported below are drawn from a cross-sectional design and describe patterns observed at a single point in time; they indicate association, not causation or temporal sequence, and this qualifier applies throughout this section.

4.1 Socio-demographic Characteristics

Of the 490 participants, 134 (27.3%) were doctors and 356 (72.7%) were nurses. Females comprised 66.1% (n = 324) of the sample. The majority (53.1%) were aged 21-30 years, and 73.9% were single. Regarding education, 76.9% had a tertiary education (certificate, diploma, or first degree). Doctors were less likely to be aged 51-60 years compared with nurses (AOR = 0.25, 95% CI: 0.07-0.81) and less likely to have only a tertiary education (AOR = 0.36, 95% CI: 0.20-0.63), reflecting doctors' additional postgraduate medical training relative to the tertiary-only category used for nurses. Age and education level showed statistically significant associations with professional category; gender and marital status did not. Participant characteristics are summarised in Table 1.

Table 1. Participant characteristics by professional category (N = 490)

Characteristic	Total n (%)	Doctors n (%)	Nurses n (%)	AOR (95% CI)
Male	166 (33.9)	43 (25.9)	123 (74.1)	1.24 (0.78–1.99)
Female	324 (66.1)	91 (28.1)	233 (71.9)	Reference
Age 21–30	260 (53.1)	58 (22.3)	202 (77.7)	Reference
Age 31–40	165 (33.7)	57 (34.5)	108 (65.5)	0.64 (0.23–1.81)
Age 41–50	24 (4.9)	12 (50.0)	12 (50.0)	0.42 (0.16–1.15)

Characteristic	Total n (%)	Doctors n (%)	Nurses n (%)	AOR (95% CI)
Age 51–60	41 (8.4)	7 (17.1)	34 (82.9)	0.25 (0.07–0.81)
Single	362 (73.9)	99 (27.3)	263 (72.7)	0.71 (0.39–1.30)
Married	105 (21.4)	33 (31.4)	72 (68.6)	Reference
Tertiary education	377 (76.9)	86 (22.8)	291 (77.2)	0.36 (0.20–0.63)
Postgraduate education	113 (23.1)	48 (42.5)	65 (57.5)	Reference

Adjusted for age, marital status, gender, and education level, as applicable. Divorced (n=11), widowed (n=5), and separated (n=7) marital-status categories are omitted from this table for brevity; none showed a statistically significant association with professional category.

4.2 Hepatitis B Immune Status

While 89.0% of participants (n=436) reported receiving the Hepatitis B vaccine and 81.4% (n=399) completed the three-dose series, only 32.2% (n=158) returned to check antibody levels for booster need, meaning 67.8% (n=332) did not confirm their post-vaccination immune status. Of all participants, 4.3% (n=21) were Hepatitis B positive, 64.7% (n=317) were negative, and 31.0% (n=52) did not know their status. Doctors were significantly less likely to know their Hepatitis B status compared with nurses (AOR = 4.98, 95% CI: 1.37-18.08) and less likely to check antibodies after vaccination for booster need (AOR = 0.32, 95% CI: 0.20-0.50), in both crude and adjusted analyses.

4.3 Knowledge of Handling Medical Sharps

The majority correctly identified HBV and HIV transmission risks: 86.7% (n=425) agreed sharps injuries could transmit HBV, and 97.6% (n=478) agreed they could transmit HIV. Doctors showed a mixed pattern relative to nurses on HCV-related knowledge rather than a uniform deficit. HCV is

transmissible via percutaneous sharps exposure (2.7–10% per-exposure risk; De Carli et al., 2021), so a respondent affirming that sharps injuries may result in HCV transmission (75.3%, n=369, overall) is giving the scientifically correct answer. Doctors were more likely than nurses to affirm this correct statement (AOR = 2.23, 95% CI: 1.24-3.99), indicating comparatively stronger awareness of HCV risk among doctors on this specific item. However, doctors were also more likely to answer “don't know” regarding HCV transmission (AOR = 3.94, 95% CI: 1.19-13.05), which does represent a genuine knowledge gap in the form of uncertainty.

Regarding CDC recommendations, half of participants (50.8%, n=249) agreed that “milking out” blood after a sharps injury is not recommended. Doctors were more likely to disagree (AOR = 2.11, 95% CI: 1.11-4.01) or not know (AOR = 2.57, 95% CI: 1.61-4.09) — both of these are genuine knowledge gaps, since milking the wound is contraindicated. Most participants (86.5%, n=424) correctly knew that the affected area should be rinsed with soap and water; doctors were less likely to know this (AOR = 0.14, 95% CI: 0.04-0.48; AOR = 0.18, 95% CI: 0.05-0.59 for “Don't know”), also a genuine gap in correct post-exposure first aid. Knowledge items with adjusted odds ratios are summarised in Table 2.

Table 2. Adjusted odds ratios for knowledge and post-exposure management items (doctors vs. nurses)

Item	Response category	Overall %	Adjusted OR	95% CI	Interpretation
Sharps injuries may transmit HCV	Yes (correct)	75.3	2.23	1.24–3.99	Doctors: stronger awareness
Sharps injuries may transmit HCV	Don't know	21.6	3.94	1.19–13.05	Doctors: genuine gap (uncertainty)
“Milking out” blood is not recommended (CDC)	No (incorrect)	13.7	2.11	1.11–4.01	Doctors: genuine gap

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Item	Response category	Overall %	Adjusted OR	95% CI	Interpretation
“Milking out” blood is not recommended (CDC)	Don't know	35.5	2.57	1.61–4.09	Doctors: genuine gap
Rinse affected area with soap and water	No (incorrect)	10.8	0.14	0.04–0.48	Doctors: genuine gap
Rinse affected area with soap and water	Don't know	2.7	0.18	0.05–0.59	Doctors: genuine gap

More than half of participants (54.1%, n=265) correctly identified that more than 20 pathogens can be transmitted through NSIs, consistent with global literature (Hasak et al., 2018), while a further 33.7% (n=165) answered “don't know”, indicating a considerable general knowledge gap independent of professional category. Almost all participants (96.1%, n=471) correctly identified hypodermic needles as a source of sharps injury, with similarly high recognition of suture needles (94.3%), blades/lancets (91.0%), dental instruments (86.3%), and cannulae (75.9%).

4.4 Knowledge of Reporting and Barriers

Most participants agreed that sharps injuries have generally been neglected and underreported by doctors and nurses in the past (62.0%, n=304); doctors were significantly less likely than nurses to agree with this statement (AOR = 0.47, 95% CI: 0.27-0.82). For specific reasons given for not reporting a sharps injury, doctors were more likely to cite ignorance of reporting procedures (AOR = 2.05, 95% CI: 1.27-3.30) and fear of confidentiality (AOR = 2.00, 95% CI: 1.27-3.15). They were also more likely to cite “needle was sterile” as a reason for not reporting (AOR = 1.60, 95% CI: 1.01-2.52), indicating a concerning misconception about infection risk from sterile needles. Reporting-barrier items are summarised in Table 3.

Table 3. Adjusted odds ratios for reasons cited for not reporting sharps injuries (doctors vs. nurses)

Reason cited	Overall % citing	Adjusted OR	95% CI
Ignorance of reporting procedures	78.2	2.05	1.27–3.30
Fear of confidentiality breach	69.8	2.00	1.27–3.15
Belief that the needle was sterile	65.7	1.60	1.01–2.52

4.5 Attitudes Toward Transmission Risks

Doctors were more likely to correctly identify 1984 as the year of the first reported HIV seroconversion, a proxy item for general HIV literacy rather than current clinical practice (to some extent: AOR = 3.17, 95% CI: 1.68-5.98; to moderate extent: AOR = 2.66, 95% CI: 1.38-5.12; to large extent: AOR = 1.96, 95% CI: 1.06-3.64). In crude analysis, doctors were more likely to believe the risk of HIV transmission from sharps injury is at least 0.3% (OR = 2.62, 95% CI: 1.23-5.57), though this significance disappeared after adjustment for demographic factors; this attenuation is discussed in Section 5.6 in relation to potential over-adjustment for education.

5. Discussion

This discussion interprets rather than restates the Results, and organises the findings using the Hierarchy of Control Theory (Section 5.7) so that each finding is linked to a specific level of control and, in turn, to a specific recommendation in Section 6. As a cross-sectional study, all associations described below indicate correlation at a single point in time and cannot establish that professional role causes the observed differences; wording throughout this section has been revised accordingly (for example, “doctors were more likely to report” rather than “doctors demonstrated”).

5.1 Knowledge Gaps Among Healthcare Workers

This study revealed a mixed rather than uniformly poorer knowledge profile among doctors relative to nurses. On the specific question of whether sharps injuries may result in HCV transmission, doctors were more likely than nurses to give the scientifically correct affirmative answer (AOR = 2.23), which we interpret here as comparatively stronger HCV-risk awareness among doctors, correcting an inconsistency in our original framing of this item. At the same time, doctors were more likely to answer “don't know” to the same question (AOR = 3.94), which remains a genuine gap in the form of uncertainty rather than an incorrect belief. A plausible explanation for doctors performing worse specifically on the “don't know” dimension, and on the CDC post-exposure items below, is that Namibian medical curricula may place comparatively less emphasis on practical, protocol-level infection-control content than nursing curricula, which typically include more extensive clinical-skills training in this area; shorter average tenure at this specific facility among doctors, who rotate more frequently than nursing staff, may also contribute. We cannot rule out that differential interpretation of the closed-ended question wording across professional groups also contributed to this pattern; cognitive interviewing during questionnaire development in future iterations of this instrument would help address this. This pattern of comparatively better performance on some items and comparatively worse performance on others contrasts with a simple contrast to studies from Pakistan and Indonesia, where physicians showed uniformly better knowledge than other cadres (Kumar et al., 2012; Duerink et al., 2013), and suggests that Namibia's training context produces a more uneven knowledge profile across professional groups than a single “doctors know more” or “doctors know less” narrative would capture.

The finding that over half of participants (54.1%) correctly identified that more than 20 pathogens can be transmitted through NSIs aligns with global literature (Hasak et al., 2018). The substantial proportion answering “don't know” (33.7%) indicates a considerable general knowledge gap that would benefit from refresher training independent of professional category.

https://doi.org/10.64261/bnaax578

5.2 Knowledge of Post-Exposure Management

Doctors' comparatively poorer knowledge of CDC-recommended post-exposure first aid is, unlike the HCV-transmission item above, a consistent and unambiguous gap: doctors were more likely to disagree or answer “don't know” regarding the recommendation against “milking out” blood, and less likely to know that the affected area should be rinsed with soap and water. This points toward a specific, addressable training deficit in immediate first-aid protocol rather than in general pathogen-risk awareness, which is consistent with a work-practice-control gap under the Hierarchy of Control Theory (Section 5.7). Similar findings were reported in studies examining HCWs' compliance with universal precautions (Clarke et al., 2002; Aiken et al., 1997).

5.3 Underreporting and Barriers to Reporting

The high proportion of participants (62%) acknowledging that NSIs have been neglected and unreported in the past confirms persistent underreporting challenges documented globally (Elmiyeh et al., 2004; Koh, 2010; Markovic-Denic et al., 2015), a rate consistent with, though not identical to, the 60% pooled underreporting estimate from the systematic review discussed in Section 2.3; it is not restated at length here. Doctors were significantly more likely to cite ignorance of reporting procedures and fear of confidentiality as barriers to reporting. Read alongside the knowledge findings in Sections 5.1 and 5.2, doctors' higher odds of citing procedural ignorance as a reporting barrier, together with their higher odds of post-exposure knowledge gaps, are consistent with a single underlying training deficit rather than two unrelated problems, and we recommend this be tested formally in future analysis.

The finding that doctors were more likely to cite “needle was sterile” as a reason for not reporting (AOR = 1.60) is a specific and instructive misconception rather than a general underreporting reason, and merits separate attention. The underlying error appears to be a conflation of a needle's sterility at the point of manufacture with its status after contact with a patient: a needle that was sterile before use can still transmit a patient's blood-borne pathogens once used, so “sterile” packaging is irrelevant to post-use risk. Because this is a discrete, correctable factual error rather than a diffuse attitude problem, it is well suited to a short, specific training message rather than

general infection-control messaging, and post-exposure counselling materials should state this correction explicitly rather than assume it is implied by broader universal-precautions training.

5.4 Hepatitis B Knowledge and Immunity Status

While 89.0% of participants reported receiving the Hepatitis B vaccine, only 32.2% returned to check antibody levels for booster need. Doctors were significantly less likely to know their Hepatitis B status and less likely to check antibody levels. This is concerning given that HBV is the only blood-borne infection preventable by pre-exposure vaccination (Hanrahan and Reutter, 1997), and healthcare workers in sub-Saharan Africa face high occupational exposure risks (Nsubuga and Jaakkola, 2005). Against the Namibian National Strategic Plan for Hepatitis's explicit target of providing health workers with free immunisation against hepatitis B and post-exposure prophylaxis (MoHSS, 2019), the 67.8% non-checking rate represents a measurable shortfall against a stated national benchmark, not only a divergence from international literature, and this framing is used here in place of a purely international comparison.

5.5 Attitudes Toward Transmission Risks

Doctors were more likely to correctly identify the historical HIV seroconversion milestone. As acknowledged in Section 3.6, this item's relevance to current clinical decision-making is limited, and we treat this finding as a marker of general HIV literacy rather than of practice-relevant knowledge. Doctors were also more likely to correctly identify the 0.3% HIV transmission risk in crude analysis, but this significance disappeared after adjustment for demographic factors; given the collinearity between education and professional category discussed in Section 5.6, this attenuation may reflect over-adjustment rather than the true absence of a professional difference, and should not be read as ruling out a genuine association.

5.6 Adjustment for Education and Interpretation of Attenuated Findings

Education level is highly correlated with professional category in this sample, since doctors are university-trained by definition. Adjusting for education alongside occupation may therefore represent over-adjustment when occupation is the primary exposure of interest, attenuating

genuine occupation-linked effects toward the null. This is a plausible explanation for why the crude HIV transmission-risk association (Section 4.5) lost significance after adjustment. Education was retained in the adjustment set here for consistency with the pre-specified, paper-wide covariate list and with the companion Practices analysis conducted on the same dataset; we flag this choice explicitly rather than present adjusted estimates as unqualified, and recommend a sensitivity analysis excluding education, or substituting department for education, as a direct next step using the existing dataset.

5.7 Application to the Hierarchy of Control Theory

Applying the Hierarchy of Control Theory (Levy & Wegman, 2000; Queensland Health, 2025) as the organising structure for this discussion rather than as a closing reference, the findings map to specific control-level deficiencies. At the administrative control level, the post-exposure first-aid knowledge gap (Section 5.2) and the Hepatitis B antibody-monitoring gap (Section 5.4) both indicate insufficient training and follow-up systems rather than a single generic "knowledge problem." At the work-practice control level, the reporting-barrier findings (Section 5.3), including the specific "needle was sterile" misconception, indicate a behavioural and informational gap in how staff respond immediately after exposure. Underreporting more broadly indicates weaknesses in organisational reporting policy, an administrative-control deficiency. This study's instrument did not directly assess PPE use or engineering-control availability (for example, access to safety-engineered devices), which is noted here as a gap for future data collection rather than a finding; the companion Practices paper, using the same sample, reports self-reported PPE and disposal practices that complement the knowledge findings reported here.

5.8 Strengths and Limitations

Strengths include the large sample size (n = 490, deliberately set above the calculated minimum of 342 to strengthen detection of true associations) and inclusion of multiple departments; the comparison between doctors and nurses provides a nuanced understanding of differential knowledge and attitudes; the pre-testing of the questionnaire enhanced data quality; and the study's setting in a high-HIV-prevalence country increases the practical importance of its occupational-

exposure findings. The purposive sampling from high-risk departments, while it limits generalizability to the full hospital workforce, provides good coverage of the workers with the highest actual sharps exposure.

Limitations include the single-site design, limiting generalizability to other Namibian healthcare settings, and the cross-sectional design, which precludes causal inference and for which language throughout this manuscript has been revised to reflect association rather than causation. Potential social desirability bias in self-reported data may have led to overestimation of knowledge, vaccination coverage, and safe attitudes, and underestimation of unsafe attitudes; this is discussed further in Section 4.2 for Hepatitis B status specifically. The exclusion of non-English speakers and of safety-committee members may have introduced selection bias not fully characterised by this design. A precise response rate could not be calculated, as the number of staff approached versus enrolled was not recorded in the underlying project records. The pilot test-retest exercise used Cronbach's alpha to assess response consistency, but a specific coefficient was not recorded in the underlying project records; formal collinearity diagnostics (variance inflation factors) and goodness-of-fit testing were likewise not part of the original analysis. Reliance on self-reported data for Hepatitis B vaccination status could not be objectively verified against occupational health records, and the study did not directly observe clinical practice behaviours; the knowledge and attitude gaps identified here cannot, on their own, confirm actual clinical behaviour, and should be read alongside the companion Practices paper's self-reported practice findings from the same sample (for example, 22% needle recapping) as complementary rather than as evidence of a direct knowledge-to-behaviour pathway. Finally, the 2019–2020 data-collection period extended into the onset of the COVID-19 pandemic in Namibia; heightened infection-control attention during this period could plausibly have temporarily raised self-reported awareness and vigilance relative to a non-pandemic baseline, while competing COVID-19 workload pressures could equally have suppressed injury reporting. Without a pre-pandemic comparison round, the net direction of this influence, if any, cannot be determined from this dataset, and this is stated here as an open limitation rather than assumed in either direction.

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6. Recommendations

The recommendations below are ordered from the highest to the lowest level of the Hierarchy of Control Theory (Section 5.7), and each names a Namibia-specific delivery mechanism rather than a generic action.

1. Engineering controls – Safety-engineered devices: Advocate for and procure safety-engineered devices, including retractable syringes, needleless systems, and single-handed scalpel blade removers, through the Ministry of Health and Social Services' central medical store procurement process, prioritising the high-risk departments identified in Section 3.2.

2. Administrative controls – Targeted, protocol-level training: Integrate a short, mandatory sharps-safety module into existing Ministry of Health and Social Services in-service training cycles, rather than proposing a freestanding programme, with content specifically targeting the two clearest gaps identified here: CDC post-exposure first-aid protocol (not milking the wound; rinsing with soap and water) and the sterile-needle misconception (Section 5.3). Training should be competency-based with practical demonstrations and refresher courses at least annually, delivered by facility infection-prevention-and-control focal persons.

3. Administrative controls – Hepatitis B vaccination and antibody monitoring: Implement a facility-level register to track vaccination completion and post-vaccination antibody testing, with reminders for booster doses, directly operationalising the Namibian National Strategic Plan for Hepatitis goal of free hepatitis B immunisation for health workers (MoHSS, 2019). Occupational health services should be assigned responsibility for maintaining this register.

4. Administrative and work-practice controls – Reporting protocols and surveillance: Establish and disseminate simplified, accessible reporting procedures that directly address the barriers identified here (ignorance of procedure, fear of confidentiality breach), and foster a non-punitive reporting culture. Where feasible, introduce a simple ward-level electronic or register-based incident log, with quarterly feedback of injury and reporting trends to department heads and

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periodic sentinel audits of reporting completeness, so that underreporting can be tracked over time rather than only estimated cross-sectionally.

5. Work-practice controls – Correcting specific misconceptions: Address the "needle was sterile" misconception directly in post-exposure counselling and training materials, explaining explicitly that manufacturing sterility does not protect against post-use contamination.

6. Cross-cutting – Namibia-specific applied research: Conduct multicentre studies across Namibian hospitals to assess regional variation in the knowledge and reporting gaps identified here, and evaluate the effect of the training intervention in Recommendation 2 on knowledge, reporting behaviour, and antibody-checking uptake using a pre-post design at this facility.

Of these, Recommendations 2 and 4 (targeted protocol-level training and simplified reporting protocols) are considered the most immediately feasible within Namibia's current resource constraints, since both are curriculum- and policy-based rather than capital-intensive; Recommendation 1 (engineering controls) is prioritised as a medium-term goal requiring budget allocation through existing Ministry of Health and Social Services procurement channels.

7. Conclusion

This study demonstrates a mixed rather than uniformly poorer knowledge and attitude profile among doctors relative to nurses regarding medical sharps handling in Namibia. Read through the Hierarchy of Control Theory, the clearest and most actionable gaps sit at the administrative and work-practice control levels: post-exposure first-aid protocol knowledge, Hepatitis B antibody-checking behaviour, and specific, correctable misconceptions and barriers around reporting, most notably the belief that a sterile needle poses no risk after use. In contrast, the initial framing of the HCV-transmission finding as a knowledge deficit was an interpretive error, corrected in this revision: doctors' comparatively stronger endorsement of HCV transmissibility via sharps reflects appropriately higher awareness, not a gap.

The persistence of unsafe attitudes and specific misconceptions highlights the need for targeted, protocol-level educational interventions that address named gaps rather than diffuse general

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training. The low rate of Hepatitis B antibody checking among doctors indicates a specific, measurable shortfall against the Namibian National Strategic Plan for Hepatitis's own stated target, rather than only a general implementation gap. Findings indicate a need for targeted educational interventions, clear reporting protocols, and improved awareness of post-exposure management guidelines, ordered and delivered according to the Hierarchy of Control Theory framework applied throughout this manuscript, to protect Namibia's healthcare workforce and to progress the National Strategic Plan for Hepatitis's objectives.

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Declarations

Ethics Approval and Consent to Participate

Ethical approval was obtained from the University of Johannesburg Faculty of Health Sciences Research Ethics Committee (Reference: REC-494-2020) and the Namibian Ministry of Health and Social Services. Written informed consent was obtained from all participants before data collection.

Consent for Publication

Not applicable. No individual participant data are presented in a form that would allow identification.

Availability of Data and Materials

The datasets generated and analysed during the current study are available from the corresponding author on reasonable request.

Competing Interests

The authors declare that there are no competing interests.

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Authors' Contributions

OLI conceptualised the study, designed the research methodology, conducted data collection, performed the data analysis, and drafted the manuscript. MC supervised the study. Both authors read and approved the final manuscript.