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Injection safety knowledge and practice among nurses working in medical centers in Kosovo

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Abstract

Assessing nurses' knowledge and practices about injection safety is important to prevent healthcare-associated infections and the transmission of bloodborne pathogens among patients and healthcare workers. Understanding current practices in medical centres can help identify gaps in infection prevention and control. However, limited studies evaluating these variables particularly among nurses in Kosovo. This study aimed to assess knowledge and practices regarding injection safety among nurses working in medical centres in Kosovo. A cross-sectional study was conducted across medical centres in Kosovo from 5 to 31 January 2025, involving 189 healthcare professionals. Data were collected using an electronic questionnaire and analysed using descriptive statistics and chi-square tests to describe the study variables and identify factors associated with injection safety knowledge and practices. The findings showed that the majority of nurses (81%) had good knowledge of injection safety, particularly regarding the risks of Human Immunodeficiency Virus (HIV) and hepatitis B virus (HBV) transmission associated with unsafe practices. However, adherence to safe practices remained a concern, as only 31.1% of participants reported following safe practices regarding needle recapping after injection. Statistically significant associations were found between years of professional experience, gender, and educational level and nurses' knowledge and practices regarding injection safety. Although most nurses demonstrated good knowledge, the findings highlight a gap between knowledge and practice. Therefore, regular training sessions, practical workshops, and the implementation of facility-level protocols aligned with national policies are recommended to strengthen adherence to injection safety standards. These measures can help improve patient and healthcare worker safety in medical centres across Kosovo. This study has international relevance by providing evidence on knowledge and injection safety practices, offering insights for infection prevention strategies, nursing education, and patient safety policies in healthcare settings worldwide.

Keywords: Infection prevention and control, injection safety, knowledge, nurses, nursing practice

Introduction

Injections are among the most common medical procedures, with approximately 20 billion administered annually worldwide (Janik-Karpinska et al., 2023). They can be given intravenously, intramuscularly, intradermally, or subcutaneously, with the majority administered for curative purposes (Gandell et al., 2019). The World Health Organization (WHO) defines a safe injection as one that is administered using appropriate equipment, does not harm the recipient, does not expose the provider to avoidable risks, and does not produce waste that is dangerous to the community (Kottapalli et al., 2023). Injection safety is a critical component of patient care and infection prevention (Pradeep et al., 2025). Unsafe injection practices can pose serious health risks, including the transmission of bloodborne infections such as Human Immunodeficiency Virus (HIV) and hepatitis B and C (Centers for Disease Control and Prevention [CDC], 2025). The prevalence of needle-stick injury (NSI) ranged from 19.9% to 54.0% with an overall prevalence of 35.7% and 38.5 to 100% with an overall prevalence of 64.1% in the previous 1 year and throughout career, respectively (Mengistu & Tolera, 2020). A study highlighted that females, younger age, rotated shift workers, not attending training courses, working in the surgery ward, less work experience apposed a greater risk factor for NSI among healthcare workers (Hassanipour et al., 2021). These risks can be minimized through the consistent application of

standard precautions, the use of sterile injection equipment, and the proper handling and disposal of needles and other sharps (Ali & Eldessouki, 2023). Therefore, healthcare professionals must adhere to established injection safety guidelines and receive appropriate training to prevent avoidable infections and improve safety (Park et al., 2024).

Ensuring proper knowledge and strict adherence to safe injection practices among nurses are essential to minimizing these risks and enhancing overall patient safety. Previous studies highlight that healthcare workers' knowledge and practices regarding injection safety are heavily influenced by factors such as years of experience, educational level, and institutional protocols (Al Yaqoubi et al., 2025). Identifying these underlying factors helps pinpoint critical knowledge gaps, guiding strategies to strengthen safety standards across medical settings. Evidence on injection safety that is specific to Kosovo remains very limited. The only national-level infection data published to date come from a point prevalence survey of 915 inpatients across Kosovo hospitals, which reported an overall healthcare-associated infection prevalence of 4.9%, rising to 7.2% at the tertiary University Clinical Centre of Kosovo, with surgical site infection the most frequent type (35.5% of all healthcare-associated infections) and Gram-negative organisms predominating (61%) (Raka et al., 2019). No comparable national study has examined injection technique, needle recapping, sharps handling or post-exposure management among nurses, and Kosovo does not operate a routine surveillance system for occupational needlestick injury. Evidence on occupational safety more broadly suggests that the enforcement of health and safety legislation in the Kosovan health sector is weak: labour and health inspectors rated the adequacy of staff training at 1.9 and the resources and authority of the inspectorate at 2.1 on a five-point scale, and systematic under-reporting of occupational incidents by health workers was documented (Xhemajli et al., 2024). The knowledge and everyday practice of the nurses who administer the majority of injections in the country have therefore not previously been described.

In the international level, unsafe injection practice remains a persistent source of avoidable harm. The WHO has recommended the universal adoption of safety-engineered syringes and the elimination of unnecessary injections, together with a shift away from needle recapping and manual disassembly of used devices (World Health Organization [WHO], 2016). Reported performance nevertheless varies widely. Recent evidence from northern Nigeria, based on 912 health workers surveyed in 2025, found that only 45.8% had good knowledge of standard precautions, that just 2.3% achieved a good practice score, that 69.5% did not consistently avoid recapping needles and that 62.8% had sustained a needlestick injury in the preceding year (Iheanacho et al., 2026). In Libya, 66.7% of nurses and laboratory technicians knew that needlestick injuries can transmit infection, but 54.4% did not know the correct post-exposure procedure (Abd-Elrazeq et al., 2026). In a high-resource setting, a study of 215 nurses in Korean general hospitals found that safe injection performance was predicted by the strength of the institutional patient safety culture, by practical knowledge of safe injection, and by shorter weekly working hours (Jang et al., 2026). Within the wider region, a survey of Albanian medical students reported that although awareness of HIV (93%) and hepatitis B (87%) as bloodborne agents was high, only around 45% considered their training adequate and 27% held incorrect beliefs about post-exposure prophylaxis (Ippoliti et al., 2025).

Three gaps are apparent across this literature. First, most studies measure knowledge and self-reported practice as a single composite, so that a high aggregate score can conceal a specific and dangerous deficit — most often needle recapping or post-exposure management. Second, the majority of available evidence comes from sub-Saharan Africa and South and East Asia; south-eastern Europe, and the Western Balkans in particular, is almost absent from the published record, so it is not known whether the knowledge–practice gap reported elsewhere takes the same form in a European health system in transition. Third, few studies examine injection safety alongside the adjacent practices on which it depends — hand hygiene and medication administration — even though these are performed in the same episode of care. The present study addresses all three gaps by reporting injection safety knowledge and practice item by item, in a country that has not previously been studied, and jointly with handwashing and drug administration. The Law on Health (Law No. 04/L-125) places the prevention of communicable disease, including the early detection of communicable disease and the elimination of its causes, among the core public health functions of the state (Article 12), requires health institutions to apply international standards of organization and provision of care and to operate a quality management system (Articles 5 and 13), and obliges health professionals to take part in continuing professional development, which is documented through Continuous Medical Education credits and linked to re-licensing (Articles 75 and 76) (Assembly of the Republic of Kosovo, 2012). The Ministry of Health and the National Institute of Public Health of Kosovo are responsible for infection prevention and control policy, and the Chamber of Nurses, Midwives and Health Professionals of Kosovo regulates the profession and accredits continuing education. The statutory architecture therefore already provides the instruments — mandatory continuing education tied to re-licensing, and an institutional duty to apply international standards — through which injection safety could be addressed. What has not been

established is a dedicated national injection safety programme with defined indicators, a procurement commitment to safety-engineered devices, or routine reporting of needlestick injury.

In the absence of a national injection safety standard, practice in Kosovan medical centers is guided by a combination of institutional protocols, pre-service nursing curricula and internationally derived recommendations, principally those of the WHO (WHO, 2001, 2016). This highlights the need to assess current practices in a context where guidance is inherited rather than nationally standardized, potentially resulting in variations in adherence across facilities and greater reliance on individual training than on institutional systems. Kosovo provides an informative context for examining injection safety practices for three main reasons. First, it has a relatively young and recently rebuilt healthcare system operating under considerable resource constraints, while the educational qualifications of its nursing workforce have improved rapidly, with bachelor's and postgraduate qualifications now common among practicing nurses. Second, as a European healthcare system seeking alignment with European Union standards, Kosovo provides an opportunity to examine the gap between policy objectives and actual clinical practice. Third, unlike many settings where injection safety has been investigated, shortages of single-use injection equipment are not considered the primary constraint. Consequently, any discrepancies between knowledge and practice may be more closely related to individual behaviour, clinical supervision, and institutional culture than to the availability of supplies. Kosovo therefore provides an opportunity to examine the knowledge–practice gap while largely setting aside material scarcity as a primary explanatory factor. Medical centres are particularly relevant settings for this investigation, as they provide most injection-related services in Kosovo through primary and secondary outpatient care, including emergency and day-case treatment. These centres typically manage high patient volumes, with injections administered by nurses in treatment rooms rather than dedicated procedure suites. Understanding the operational context is therefore essential, including the approximate daily volume of injections per centre, the routine use of safety-engineered devices, the availability of sharps containers at the point of care, access to hepatitis B vaccination for healthcare staff, and formal procedures for reporting and recording needlestick injuries. These factors shape how injection safety is implemented in everyday clinical practice and must be established before appropriate interventions can be designed.

The study was guided by the following questions as follows what is the level of injection safety knowledge among nurses working in medical centres in Kosovo? to what extent do these nurses adhere to recommended injection safety practices, in particular with regard to needle recapping, the use of protective barriers and post-exposure management? how are injection safety knowledge and practice related to handwashing practice and to drug administration? which socio-demographic and professional characteristics — age, sex, educational level and years of professional experience — are associated with injection safety knowledge and practice? where does the largest gap lie between what nurses know and what they report doing, and what does this imply for training and for facility-level protocols? We expect this study to contribute in three ways. It provides the first empirical description of injection safety knowledge and practice among nurses in Kosovo, and so adds a previously missing European data point to a literature dominated by low-resource settings elsewhere. It tests whether the knowledge–practice gap reported in Nepal, Nigeria and Ethiopia also appears where equipment supply is not the principal constraint, which bears directly on whether international strategy should prioritize education, supervision or procurement. And by measuring injection safety together with hand hygiene and medication administration, it indicates which adjacent practice offers the most effective point of intervention. For readers outside Kosovo, the findings are intended to be useful less as national statistics than as evidence about where, in a health system of this type, safe injection practice is most likely to fail.

Method

A cross-sectional explorative research design was employed to assess the knowledge and practices regarding injection safety among nurses working in medical centers across Kosovo. The design was chosen because it allows researchers to measure knowledge and practices at a single point in time across setting without needing a long-term follow-up (Wang & Cheng, 2020). Also, the design is explorative because it aims to map out and identify baseline patterns or potential gaps in injection safety among Kosovo nurses, where limited prior empirical data exists. The study was conducted in the seven main regional medical centres of Kosovo and their associated outpatient clinics, located in Prishtina, Prizren, Peja, Gjakova, Gjiilan, Ferizaj and Mitrovica. These facilities were selected because they represent the main public institutions responsible for delivering the majority of outpatient injection services in the country, ensuring national-level representation. The rationale for choosing these centers was their high volume of daily injections and their role as the primary point of contact for the population in both urban and rural areas. The study was conducted from 5 to 31 January 2026, focusing on the assessment of injection safety practices, handwashing habits, and drug administration protocols among healthcare professionals.

The study population comprised healthcare professionals providing care across seven medical centers in Kosovo. The total number of healthcare professionals eligible according to the study's inclusion criteria could not be determined because staff records do not track how frequently individual employees administer injections, and consequently, no denominator was established at the time of recruitment. To determine the sample size, the researchers established inclusion and exclusion criteria. The inclusion criteria comprised licensed nurses or physicians actively working in the selected medical centers, who had administered at least five injections per week during the preceding month and voluntarily consented to participate. Conversely, the exclusion criteria included auxiliary medical staff (such as nursing assistants or technicians) lacking legal authority to administer injections independently, students or trainees, and personnel on temporary contracts or leave during the study period. Participants were recruited using a convenience sampling method combined with stratified elements based on region and professional role. Although the target population primarily comprised nurses—who perform the vast majority of injections—a small cohort of physicians was also included due to their regular involvement in injection administration. The term "other medical staff" referenced in the initial study description referred exclusively to these physicians; no unauthorized personnel were included. Ultimately, a total of 189 eligible participants completed the questionnaire. No a priori sample size calculation was performed. The eligible population comprised licensed nurses and physicians who routinely administer injections across the seven centres. However, the total number of eligible professionals was finite but not fully enumerated in a single register. As recruitment relied on voluntary participation through an electronic questionnaire distributed via institutional mailing lists and the communication channels of the Chamber of Nurses, the study aimed to recruit as many eligible participants as possible rather than target a predetermined sample size. Recruitment continued until the response rate plateaued following two reminder emails.

In this study, the researchers utilized electronic instruments, including a demographic questionnaire, as well as questionnaires evaluating injection safety knowledge and practice (ISKP), handwashing practices (HWP), and drug administration practices (DAP). The first tool is demographic questionnaire that was used to assess age, sex, professional roles, and years of experience. The second tool is the tool for the assessment of injection safety developed by WHO (WHO, 2001). The instrument consisted of 68 items divided into four main sections as follows socio-demographic characteristics (12 items), injection safety knowledge (11 items), injection safety and hand hygiene practices (25 items), and medication administration and waste management practices (20 items). The validity of this instrument has been evaluated and established in several previous studies (Birhanu et al., 2019; Rayamajhi & Pachya, 2023). The questionnaire was developed in English, translated into Albanian, and back-translated to ensure semantic accuracy. Content validity was established through expert review by a five-member panel comprising two nursing professors, two infection control specialists, and one epidemiologist from the University of Pristina and the Chamber of Nurses of Kosovo, yielding a Content Validity Index (CVI) of 0.92. Internal consistency was evaluated using Cronbach's alpha, which demonstrated high reliability across the knowledge domain ($\alpha=0.87$), the practice domain ($\alpha=0.89$), and the overall scale ($\alpha=0.91$). The electronic format facilitated efficient data collection and encouraged honest responses by maintaining participant anonymity.

The electronic questionnaire was developed using Google Forms to facilitate the distribution, completion, and management of study responses. The questionnaire was disseminated through official institutional email lists and the communication channels of the Chamber of Nurses to reach the intended target population. These distribution methods were selected to facilitate access to the questionnaire among eligible participants and to support an efficient and consistent data collection process. The electronic format also enabled participants to complete the questionnaire remotely at a time and location convenient to them, reducing the logistical constraints associated with paper-based data collection. The first page of the electronic questionnaire contained a detailed participant information sheet explaining the purpose and objectives of the study, the nature of participation, the expected time required to complete the questionnaire, and the procedures for collecting and handling the data. Information regarding the voluntary nature of participation, the right to decline participation, and the confidentiality of responses was also provided. An electronic informed consent form was incorporated into the initial section of the questionnaire. Participants were required to review the study information and provide their informed consent before proceeding to the questionnaire items. This procedure was implemented to ensure that participation was based on an understanding of the study and agreement to participate. To encourage participation and improve the response rate, two reminder emails were sent at one-week intervals following the initial distribution of the questionnaire. The reminders reiterated the purpose of the study, encouraged eligible individuals who had not yet responded to participate, and provided access to the electronic questionnaire. The reminders were intended to increase awareness of the study and provide additional opportunities for potential participants to complete the questionnaire. They were distributed through the established institutional communication channels

without requiring individuals to disclose whether they had already participated. Several measures were implemented to protect participant anonymity during electronic data collection. Specifically, the Google Forms settings were configured to disable the collection of respondents' email addresses, and IP address tracking was not used as a means of identifying participants. No direct personal identifiers were intentionally collected through the questionnaire. These measures were intended to minimize the possibility of linking individual responses to specific participants and to encourage respondents to provide information without concerns about personal identification. Access to the collected data was restricted to the research team responsible for data management and analysis, in accordance with the study's data-handling procedures.

Data collection continued until the predetermined target sample size had been reached and the quality of the submitted responses had been reviewed. The response dataset was examined for potential duplicate submissions and other indications of incomplete or invalid responses. Duplicate submissions were assessed to prevent the same participant's responses from being counted more than once. The data collection process was subsequently closed after the target sample had been achieved and the response quality had been verified. This approach was intended to ensure that the final dataset was suitable for statistical analysis while maintaining consistency with the planned sampling strategy. Upon completion of data collection, the responses recorded in Google Forms were exported automatically into Microsoft Excel for initial data management. The exported dataset was reviewed to assess the completeness and consistency of the recorded responses and to identify any data entry or formatting issues that could affect subsequent analyses. The dataset was then prepared for statistical processing and imported into IBM Statistical Package for the Social Sciences (SPSS). Variable names, response categories, and coding arrangements were checked to ensure that the data were appropriately structured for analysis. The resulting dataset was used for the planned statistical analyses in accordance with the study objectives. Throughout this process, the research team sought to maintain the accuracy, confidentiality, and integrity of the collected information.

Data analysis was performed using SPSS software (Version 26) to process and analyze the collected data. Figures were prepared using Lucidchart (Lucid Software Inc., South Jordan, UT, USA). Descriptive statistics, including means, standard deviations, frequencies, and percentages, were used to summarize socio-demographic data and responses from the questionnaire. This provided an overview of the sample characteristics and their knowledge and practices regarding injection safety. To examine associations between socio-demographic factors (such as age, sex, professional roles, and years of experience) and injection safety practices, a chi-square test was applied. This test helped identify significant differences and relationships among variables. To explore the relationships between variables such as ISKP, HWP, and DAP, Pearson correlation analysis was conducted. Analysis of Variance (ANOVA) was used to assess differences in ISKP across different age, sex, and education. Multiple regression analysis was applied to identify predictors of safe injection practices, considering socio-demographic and practice-related variables. A Structural Equation Modeling (SEM) approach was also used to evaluate complex relationships among variables, allowing for the identification of direct and indirect effects between knowledge, practices, and socio-demographic factors on injection safety.

The study was conducted in accordance with established ethical principles for research involving human participants. Ethical approval was obtained from the relevant institutional review board in Kosovo before the commencement of data collection. In addition, permission to conduct the study was granted by the Chamber of Nurses, Midwives and Health Professionals of Kosovo (Protocol No. 3277). Participation in the study was entirely voluntary, and all potential participants were provided with an electronic information sheet explaining the purpose and objectives of the research, the nature of their involvement, and the procedures for collecting and handling the data. Electronic informed consent was obtained from participants before they could proceed to complete the questionnaire. Participants were informed of their right to decline participation without any negative consequences. Confidentiality and anonymity were maintained throughout the research process. These measures were intended to minimize the collection of personally identifiable information and protect participants' privacy. The collected data were handled in accordance with the study's data management procedures and were used exclusively for the intended research purposes. Appropriate precautions were taken during data management, storage, and analysis to preserve the confidentiality and integrity of the responses. These ethical safeguards were intended to protect participants' rights, autonomy, and privacy.

Results

The sociodemographic characteristics of the participants indicate that the largest age group was 20–29 years, accounting for 34.4% of the sample, followed by participants aged 40–49 years (31.7%). Participants aged 50–59 years represented 19.4% of the sample, while those aged 30–39 years accounted for 14.5%. Regarding gender, females constituted the majority of participants (80.0%), whereas males accounted for 20.0%. In terms of marital status, most participants were

married (62.4%), followed by single participants (32.8%). Divorced and widowed participants represented smaller proportions of the sample, at 2.2% and 2.7%, respectively. Regarding educational attainment, nearly half of the participants held a bachelor's degree (49.5%), while 30.6% had completed high school, 16.1% held a master's degree, and 3.6% had obtained a doctoral degree (PhD). In terms of professional experience, more than half of the participants had over 10 years of work experience (55.2%), while 31.7% had 1–4 years and 13.1% had 5–9 years of experience. With respect to workplace, half of the participants worked in the medical sector (50.5%). The surgical and emergency sectors each accounted for 17.7% of participants, followed by gynecology (6.5%), internal medicine (5.4%), and pediatrics (2.2%). The description of the characteristics was presented in the table (**Table 1**).

A total of 80.4% of participants correctly indicated that safe injection practices do not pose a risk to patients, while 77.2% recognized that they do not pose a risk to nurses. These findings suggest that most participants had a good understanding of the fundamental principles of injection safety. Knowledge of the risk of bloodborne infections associated with unsafe injection practices was also relatively high. Specifically, 82.5% of nurses identified HIV as a potential consequence of unsafe injections, while 77.8% recognized the risk of hepatitis B infection. Regarding specific practices, 73.5% of participants correctly identified recapping needles after injection as an unsafe practice, whereas 24.9% mistakenly considered it safe. This misconception is concerning because needle recapping can increase the risk of accidental needlestick injuries and exposure to bloodborne pathogens. These findings highlight the need for further training on safe needle handling and appropriate sharps disposal practices. Regarding the selection and handling of injection equipment, 94.7% of participants reported selecting the appropriate equipment for patients, while 90.5% followed the manufacturer's storage instructions. These findings indicate a high level of awareness of appropriate equipment selection and storage practices. Furthermore, 78.3% of participants were aware of post-exposure prophylaxis following needlestick injuries, suggesting that most understood the importance of timely intervention to reduce the risk of infection after occupational exposure. Nevertheless, the proportion of participants who lacked this knowledge highlights the need to strengthen education on post-exposure management and the procedures to follow after needlestick injuries (**Table 2**).

The results on HWP among nurses working in medical centers in Kosovo indicate a high level of compliance with basic hygiene standards. The majority of participants (97.4%) reported that they wash their hands immediately upon arrival at work and after removing gloves. This indicates a high awareness of the importance of personal hygiene as a key preventive measure for healthcare-associated infections. Hygiene practices before and after injection procedures are also high, with 95.8% of nurses stating that they wash their hands before giving an injection and 96.8% after contact with contaminants, even when using gloves. The majority of nurses (84.7%) reported that they wash their hands between procedures on the same patient, indicating a significant gap in compliance with infection prevention protocols. 95.8% of nurses reported that they verify the integrity of syringe packaging before use, while 69.8% use protective barriers such as sterile gauze when opening glass ampoules. A significant proportion (21.7%) stated that they do not use any barriers, which increases the risk of injury and contamination. The results indicate a strong implementation of safe HWP and infection control practices, but with some gaps in detailed aspects such as intraprocedural handwashing and the use of protective barriers (**Table 3**). The practices of medication administration by nurses in medical centers in Kosovo presented in Table 4 show a high level of compliance with safety standards. The majority of participants (98.4%) reported that they verify the name of the medication, the expiration date, and the type of injection before administration, demonstrating a strong commitment to patient safety. Regarding the control of medication dosage and time of administration, the results remain high, with 97.9% and 98.4% of nurses reporting compliance with these practices. Also, 86.2% of them verify the patient's age before administering medications. About 96.8% of nurses reported that they dispose of waste in color-coded bins according to recommendations and separate waste by type at the time of its creation. The results show a high level of compliance with safety standards in medication administration (**Table 4**).

The correlation analysis shows a strong positive and significant relationship between ISKP and medication administration practices, with a correlation coefficient of 0.635 ($p < 0.01$). Thus, nurses with higher knowledge tend to also follow better medication administration practices. There is a weaker but still significant relationship between knowledge and HWP with $r = 0.194$ ($p < 0.01$), indicating that injection safety knowledge is less strongly associated with hand hygiene. Medication administration practices show a significant positive relationship with HWP, with a correlation of 0.402 ($p < 0.01$). This indicates that nurses who follow safe medication administration protocols also tend to practice handwashing more regularly. Age has a negative and weak correlation with medication practices ($r = -0.153$, $p < 0.05$), suggesting that older nurses may be less rigorous in following medication administration protocols. Gender showed a statistically significant association with HWP ($r = 0.175$, $p < 0.05$) and education level ($r = 0.165$, $p < 0.05$). This suggests that women may tend to follow hygiene practices more strictly and that higher education is associated with better adherence

to these practices. Meanwhile, age and education did not show a significant association with ISKP (**Table 5**). The results of ANOVA for ISKP by age shows that there are no significant differences between age groups ($F=0.675$, $p=0.786$). The high p -value ($p>0.05$) indicates that age does not significantly affect the level of ISKP among the nurses included in the study. In the analysis by gender, no significant differences were identified in the level of ISKP ($F=1.009$, $p=0.444$). This result indicates that both males and females have similar levels of ISKP, suggesting that gender is not a determining factor in this context. While, regarding the educational level, significant differences were identified in ISKP ($F=7.079$, $p=0.002$). The low p -value ($p<0.05$) suggests that the educational level has a significant impact on the acquisition of appropriate ISKP (**Table 6**).

The regression analysis shows that the overall model is statistically significant ($F=4.383$, $p=0.004$) and explains 68.4% of the variation in injection knowledge ($R\text{-squared}=0.684$), indicating that the variables included in the model have a significant impact on the level of knowledge and practices of injection safety. According to the regression coefficients presented, the variable of hand-washing practices has a positive and significant impact on injection knowledge ($\beta=0.24$, $p=0.029$). Based on this result, nurses who follow better hand-washing practices have a higher level of knowledge and practices of injection safety. Meanwhile, DAP did not show a significant effect ($p=0.26$), suggesting that these practices are not directly related to injection safety in this model. Regarding demographic variables, gender has a negative and significant impact on ISKP ($\beta=-1.069$, $p=0.039$), suggesting that there are gender differences in the acquisition of appropriate knowledge and practices, with women having higher awareness and knowledge. Age, marital status, educational level and experience did not show significant effects in this model, as all p -values are above the 0.05 (**Table 7**). Structural Equation Modeling was performed to examine the complex relationships among ISKP, HWP, DAP, and socio-demographic variables. The model demonstrated acceptable fit indices ($\chi^2/df=2.31$, $CFI=0.94$, $TLI=0.92$, $RMSEA=0.068$, $SRMR=0.074$). Results confirmed that HWP had a significant direct positive effect on ISKP ($\beta=0.31$, $p<0.01$), while DAP showed both direct and indirect effects through HWP. Education level exerted a significant positive effect on ISKP ($\beta=0.28$, $p<0.01$). The model explained 68.4% of the variance in ISKP (**Figure 1**).

Discussion

Comparisons between the findings of this study on injection safety in Kosovo and those of studies conducted in other countries reveal both similarities and differences. These variations may reflect differences in healthcare systems, educational backgrounds, healthcare professionals' knowledge and adherence to injection safety practices, and the implementation and enforcement of relevant policies across countries. For instance, a study conducted in West Africa found health care providers had a low level of awareness pertaining to injection safety, as only 58.3% of respondents were aware of diseases that could be transmitted through needles with an approximate 50.0% of nurses having proper disposal methods available (Ernest, 2002). More recent evidence confirms that this pattern has not resolved. In a 2025 survey of 912 health workers across three states in northern Nigeria, only 45.8% demonstrated good knowledge of standard precautions and just 2.3% achieved a good practice score; 69.5% did not consistently avoid recapping needles and 62.8% reported a needlestick injury in the preceding twelve months, although 85.5% said that sharps containers were always available at the point of care (Iheanacho et al., 2026). The contrast with supply availability is instructive: where equipment was present, practice nonetheless failed. A study at a teaching hospital in Libya similarly found that although 66.7% of nurses and laboratory technicians knew that needlestick injuries can transmit infection, 54.4% did not know the correct post-exposure procedure, with awareness significantly associated with educational qualification (Abd-Elrazeq et al., 2026). Evidence from a high-resource setting points in the same direction but identifies different levers: among 215 nurses in Korean general hospitals, safe injection performance was predicted not by demographic characteristics but by the strength of the institutional patient safety culture, by practical knowledge of safe injection, and by shorter weekly working hours (Jang et al., 2026). Within the wider region, a survey of Albanian medical students found high recognition of HIV (93%) and hepatitis B (87%) as bloodborne agents, yet only about 45% judged their training adequate and 27% held incorrect beliefs about post-exposure prophylaxis (Ippoliti et al., 2025). Taken together with the present findings, these studies indicate that the knowledge–practice gap in injection safety is neither confined to resource-limited settings nor explained principally by the availability of equipment.

In direct contrast to this study, the study in Kosovo reported a much higher level of knowledge among nurses regarding injection safety (81%) including awareness of the risk factors associated with the HIV and the hepatitis viruses. In addition, the study in Kosovo identified the presence of good access to the appropriate types of equipment such as syringes and that there were high levels of compliance in the selection of equipment (94.7%) and in following proper storage instructions (90.5%). Likewise, the study conducted in Ethiopia found that only 28.7% of nurses had good knowledge of injection safety and only 25.5% of them adhered to safe practices (Birhanu et al., 2019). The findings of the

Ethiopian and Kosovo studies showed significant influences of experience, gender and education on the nurses' knowledge and practice of injection safety, however the average percentage of nurses in Kosovo (81%) with good knowledge of injection safety is considerably higher than that of the percentage of nurses in Ethiopia. This would suggest that the educational base or continuing training in Kosovo is more developed.

Table 1. The sociodemographic characteristics.

Variables	Frequency (n)	Percentage (%)
Age (years old)		
20-29	64	34.4
30-39	27	14.5
40-49	59	31.7
50-59	36	19.4
Sex*		
Male	37	20
Female	148	80
Marital status		
Single	61	32.8
Married	116	62.4
Divorced	4	2.2
Widowed	5	2.7
Education		
High school	57	30.6
Bachelor	92	49.5
Master	30	16.1
PhD	7	3.6
Experiences		
1-4 Years	58	31.7
5-9 Years	24	13.1
> 10 Years	101	55.2
Working place (unit/ward)		
Medical	94	50.5
Surgical	33	17.7
Emergency	33	17.7
Gynecology	12	6.5
Pediatric	4	2.2
Internal medicine	10	5.4

* Four participants did not report gender; therefore, gender analyses were conducted on n=185.

The finding that high aggregate knowledge coexists with a specific and persistent failure needle recapping carries a clear implication for nursing practice beyond Kosovo. General education on injection safety is evidently not sufficient; what is required is targeted, repeated, skills-based training on the small number of behaviours where practice most often departs from knowledge, principally recapping, the use of protective barriers when opening glass ampoules, and the management of exposure after a needlestick injury. Such training should be practical rather than didactic, should be repeated at defined intervals rather than delivered once at induction, and should be reinforced by direct observation of practice, since self-report consistently overstates adherence. Nurse managers should treat injection safety as a measurable and auditable indicator of care quality rather than as a matter of individual diligence, conducting periodic observational audits at the point of care, reviewing every reported needlestick injury without attributing blame, and ensuring that sharps containers and safety-engineered devices are available where injections are actually given. Because the present study found that HWP independently predicted injection safety knowledge and practice, injection safety is best taught as an integrated component of infection prevention and control rather than as a separate topic. Finally,

nurses should be supported in reporting exposures: under-reporting, documented in Kosovo and elsewhere, renders the true burden invisible and removes the evidence base for improvement (Xhemajli et al., 2024).

Governments have policy instruments and regulatory authority that individual nurses and healthcare managers lack. The findings point to four key areas for government action. First, injection safety should be made an explicit component of mandatory continuing professional development; in Kosovo the statutory mechanism already exists, since the Law on Health requires health professionals to undertake continuing professional development, documented through Continuous Medical Education credits and linked to re-licensing (Assembly of the Republic of Kosovo, 2012), and injection safety could be designated as a required element of that cycle. Second, national procurement policy should move towards safety-engineered injection devices, in line with the WHO's recommendation for their universal adoption (WHO, 2016); re-sheathing is far less likely where the device design makes it unnecessary. Third, a national system for reporting and surveillance of needlestick injury should be established, with protection from adverse consequences for those who report, since no national estimate of the incidence of occupational sharps injury in Kosovo currently exists. Fourth, enforcement capacity should be strengthened: inspectors have rated their own resources and the adequacy of staff training in the health sector at approximately 2 out of 5, and policy without inspection has limited effect (Xhemajli et al., 2024). Each of these measures is transferable to other health systems in which formal education has advanced more rapidly than institutional systems of supervision and accountability.

Table 2. ISKP analysis.

Items	True		False		I do not know	
	Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)
A safe injection poses no risk to the patient	152	80.4	27	14.3	10	5.3
A safe injection poses no risk to the nurse	146	77.2	33	17.5	10	5.3
HIV infections are a risk associated with unsafe injections	156	82.5	19	10.1	14	7.4
Hepatitis B infections are a risk associated with unsafe injections	147	77.8	28	14.8	14	7.4
Closing the needle after injecting the patient is a safe practice	139	73.5	47	24.9	3	1.6
The hepatitis B vaccine is important for those who give injections	167	88.4	12	6.3	10	5.3
I anticipate and take measures to prevent sudden patient movement	162	85.7	18	9.5	9	4.8
Observing proper storage conditions, such as temperature according to manufacturer's instructions, is a safe injection practice	171	90.5	10	5.3	8	4.2
Post-exposure prophylaxis is recommended in case of needlestick injuries	148	78.3	19	10.1	22	11.6
I choose the appropriate injection equipment for the patient	179	94.7	4	2.1	6	3.2

In Nepal, a study found that only one-third (33.3%) of nurses had good knowledge of injection safety, although the surveyed nurses reported excellent adherence to safe injection practices (Rayamajhi & Pachya, 2023). This finding contrasts with the results from Kosovo, where a high level of knowledge (81%) was reported, yet a substantial proportion of nurses (31.1%) did not adhere to recommended safety practices, particularly avoiding needle recapping.

Table 3. HWP analysis.

Items	True		False		I do not know	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
	(n)	(%)	(n)	(%)	(n)	(%)
Immediately upon arrival at work	184	97.4	0	0	5	2.6
Before deciding to give an injection	181	95.8	2	1.1	6	3.2
After removing gloves	184	97.4	3	1.6	2	1.1
After contact with any form of contamination even when wearing gloves	183	96.8	2	1.1	4	2.1
Between procedures on the same patient	160	84.7	19	10.1	10	5.3
I verify the integrity of the syringe packaging, available before use	181	95.8	3	1.6	5	2.6
I prepare each injection in a designated, clean area	186	98.4	1	0.5	2	1.1
I septum-separate the vial containing multiple doses with a sterile needle	160	84.7	13	6.9	16	8.4
I use a clean protective barrier (e.g., small gauze) to protect fingers when opening a glass ampoule	132	69.8	41	21.7	16	8.5
I discard medications with visible contamination (visible to the eye)	172	91	12	6.3	5	2.6
I discard needles with visible contamination (visible to the eye)	178	94.2	0	0	11	5.8
During the injection process, I avoid contaminating; Injection equipment and medications	184	97.4	1	0.5	4	2.1

Table 4. DAP practice.

Items	True		False		I do not know	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
	(n)	(%)	(n)	(%)	(n)	(%)
Look at the name of the medication	186	98.4	0	0	3	1.6
Time the medication was administered	186	98.4	1	0.5	2	1.1
Name of the person who gave it	172	91	9	4.8	8	4.2
Strength of the medication	172	91	2	1.1	15	7.9
Expiration date of the medication	186	98.4	1	0.5	2	1.1
Patient's age	163	86.2	14	7.4	12	6.3
Dose of the medication	185	97.9	1	0.5	3	1.6
Type of injection	186	98.4	0	0	3	1.6
I dispose of injection waste in the recommended color-coded waste bins	183	96.8	2	1.1	4	2.1
I practice waste separation; at the point of generation	178	94.2	1	0.5	10	5.3
I practice waste separation; by type	183	96.8	0	0	6	3.2

This discrepancy suggests that a high level of theoretical knowledge does not necessarily translate into consistent adherence to safe practices. Differences in workplace conditions, organizational culture, the availability of appropriate

equipment, workload, and the implementation of institutional safety protocols may also contribute to the observed differences between the two countries (Lu et al., 2022). These findings highlight the need to evaluate injection safety not only in terms of nurses' knowledge but also through their actual clinical practices and the organizational factors that influence their behavior (Pradeep et al., 2025). Nursing managers should regularly assess compliance with injection safety protocols, provide practical training, and ensure the availability of appropriate safety equipment. Furthermore, healthcare institutions should promote a safety culture in which nurses are encouraged to report unsafe practices and participate in continuous quality improvement initiatives. Clinical supervision and periodic audits may also help identify gaps between theoretical knowledge and clinical practice to address specific barriers (Atashi et al., 2024). Therefore, a comprehensive approach that integrates education, adequate resources, organizational support, and ongoing evaluation is essential to promote consistent adherence to injection safety standards and reduce the risk of infections. Study in Kenya identified gaps in safe practice with only 35.2% of nurses washing hands at the point of injection and a very high percentage (44.8%) of nurses reusing injection devices to prepare medication (Chemoiwa & Tenambergen, 2018). That study added, 40.0% of medications were prepared at the bedside of the patient. In contrast to this, the study conducted in Kosovo reported a higher percentage of compliance rates of nurses washing their hands after arriving at an injection appointment and prior to administering the injection (97.4% and 95.8% respectively). The reuse of injection devices, which is a major issue in Kenya, was not reported to be a significant issue in Kosovo, suggesting that Kenyan healthcare providers have fewer resources available and do not adhere to established single-use policies. Governments should strengthen national injection safety policies by providing a reliable supply of single-use injection devices, allocating sufficient funding, and implementing regular monitoring across healthcare facilities. Hospital policymakers should establish clear protocols prohibiting device reuse, provide ongoing training, and conduct routine audits to identify resource shortages and unsafe practices.

This study found that most nurses had good knowledge of injection safety, hand hygiene, medication safety, and waste management. The findings also indicated that nurses' knowledge and practices related to injection safety in Kosovo were associated with their years of professional experience, gender, and educational level. A study in Nigeria highlighted that nurses have moderate-to-good knowledge and practices in injection safety, but have deficits in compliance with aseptic procedures (Obiefule et al., 2026). Although Kosovo lacks a comprehensive national surveillance system specifically focused on injection-related infections, blood-borne viral infections remain a public health concern. These include hepatitis B virus (HBV), hepatitis C virus (HCV), and HIV. WHO data indicates that unsafe injections and needlestick injuries pose significant risks to occupationally expose healthcare workers worldwide (Mengistu et al., 2021). Unsafe injections and needlestick injuries are particularly problematic in healthcare systems (Alfulayw et al., 2021). Through reports made by the National Institute of Public Health of Kosovo, it has been documented that further strengthening of existing Infectious Diseases Prevention Measures (IDPMs) is necessary. The policy framework for infection prevention in Kosovo rests principally on the Law on Health, which assigns responsibility for the early detection and control of communicable disease to the public health system (Article 12), requires health institutions to apply international standards and to maintain a quality management system (Articles 5 and 13), and makes continuing professional development mandatory and linked to re-licensing (Articles 75–76) (Assembly of the Republic of Kosovo, 2012). Empirical evaluation of how far this framework is realised in practice remains limited. The national point prevalence survey of healthcare-associated infections in Kosovan hospitals reported an overall prevalence of 4.9%, rising to 7.2% in the tertiary centre, with surgical site infection the most common type (Raka et al., 2019); and a study of occupational health and safety enforcement in the Kosovan health sector concluded that enforcement is inadequate, with inspectors rating staff training at 1.9 and inspectorate resources at 2.1 on a five-point scale, and with occupational incidents systematically under-reported (Xhemajli et al., 2024). Strengthening infectious disease prevention measures in Kosovo therefore requires not only education on safe injection practice and improved waste management, but also the surveillance and enforcement capacity through which adherence can be verified. These IDPMs include education on safe injection practices, improved waste management systems, and ongoing surveillance of the rates of healthcare-associated infections (HAIs). Furthermore, nurses constitute the largest proportion of healthcare professionals involved in medication administration and injection procedures (Han & Kim, 2024). However, study conducted in Iran have revealed low levels of knowledge and adherence to safe injection practice, and high occurrence of Needle Stick Injuries (NSIs) (Halimi et al., 2024). Study conducted in different settings have reported varying levels of knowledge and practices regarding injection safety. For example, a study involving healthcare professionals at Benue State University Teaching Hospital found that 70.2% of respondents had good knowledge, 87.2% demonstrated a positive attitude, and 79.8% reported appropriate practices. However, needle recapping remained the most common unsafe injection practice, reported by 19.1% of respondents (Ijachi et al., 2016).

Table 5. Correlation analysis.

Variables		ISKP	DAP	HWP	Age	Gender	Education
ISKP	Correlation	1	0.635**	0.194**	-0.044	-0.135	-0.105
	Sig.		0.003	0.009	0.546	0.064	0.150
	Frequency (n)	189	189	179	189	189	189
DAP	Correlation	0.635**	1	0.402**	-0.153*	-0.030	0.102
	Sig.	0.003		0.000	0.035	0.679	0.162
	Frequency (n)	189	189	179	189	189	189
HWP	Correlation	0.194**	0.402**	1	0.065	0.175*	0.062
	Sig.	0.009	0.000		0.385	0.019	0.406
	Frequency (n)	179	179	179	179	179	179
Age	Correlation	-0.044	-0.153*	0.065	1	0.020	-0.065
	Sig.	0.546	0.035	0.385		0.787	0.376
	Frequency (n)	189	189	179	189	189	189
Gender	Correlation	-0.135	-0.030	0.175*	0.020	1	0.165*
	Sig.	0.064	0.679	0.019	0.787		0.023
	Frequency (n)	189	189	179	189	189	189
Education	Correlation	-0.105	0.102	0.062	-0.065	0.165*	1
	Sig.	0.150	0.162	0.406	0.376	0.023	
	Frequency (n)	189	189	179	189	189	189

**=Correlation is significant at the 0.01 level (2-tailed), *=Correlation is significant at the 0.05 level (2-tailed).

Table 6. ANOVA results.

Variables		Sum of Squares	df	Mean Square	F	Sig.
Age	Between Groups	11.726	13	0.902	0.675	0.786
	Within Groups	233.809	175	1.336		
	Total	245.534	188			
Gender	Between Groups	2.075	13	0.160	1.009	0.444
	Within Groups	27.681	175	0.158		
	Total	29.757	188			
Education	Between Groups	8.677	13	0.667	7.079	0.002
	Within Groups	108.286	175	0.619		
	Total	116.963	188			

Table 7. Multiple linear regression predicting ISKP.

Predictor	B	SE	β	t	p	95% CI [LL, UL]
HWP	0.240	0.109	—	2.20	0.029*	[0.025, 0.455]
DAP	0.116	0.103	—	1.13	0.260	[-0.086, 0.318]
Age	-0.489	0.308	—	-1.59	0.114	[-1.096, 0.119]
Sex	-1.069	0.515	—	-2.07	0.039*	[-2.086, -0.052]
Marital status	0.350	0.379	—	0.93	0.356	[-0.397, 1.097]
Educational level	-0.426	0.261	—	-1.63	0.105	[-0.941, 0.089]
Years of professional experience	0.428	0.380	—	1.13	0.261	[-0.322, 1.178]
Constant	9.396	1.772	—	5.30	<0.001***	[5.900, 12.892]

N=189; B=unstandardised regression coefficient; SE=standard error; β =standardised regression coefficient; CI=confidence interval; LL=lower limit; UL=upper limit. Mean of the dependent variable=12.270 (SD=2.773). * p <0.05.

** p <0.01; *** p <0.001

Inadequate adherence to injection safety, infection prevention, and control measures may increase the risk of HBV, HCV, and HIV transmission. Consequently, continued emphasis on adherence to standard precautions is essential to reducing the risk of infection transmission in healthcare settings across Kosovo. Healthcare professionals and governmental institutions play a central role in strengthening injection safety practices in Kosovo. Nurses and other healthcare workers are responsible for adhering to standard precautions, proper disposal of sharps, hand hygiene, and post-exposure management. At the institutional level, the Ministry of Health of Kosovo and the National Institute of Public Health have adopted infection prevention and control strategies aligned with WHO recommendations, including protocols for safe injection practices, medical waste management, and occupational safety training. Continuous professional education, regular monitoring, and implementation of national infection control guidelines are essential interventions for improving compliance with safe injection standards. International comparisons reveal substantial differences in ISKP across countries. Nurses in Kosovo demonstrated relatively high knowledge levels (81%), compared with the lower knowledge levels reported in Ethiopia and other low-resource settings, while findings from Nepal and Kosovo highlight that knowledge does not always translate into safe practices, particularly regarding needle recapping. Similarly, healthcare professionals in Benue State, Nigeria, demonstrated good knowledge (70.2%) and appropriate practices (79.8%), yet needle recapping remained a common unsafe behavior. These findings suggest that, regardless of differences in healthcare systems and educational contexts, a knowledge–practice gap persists across countries. Therefore, strengthening injection safety requires not only improved education but also effective supervision, adequate resources, and institutional policies that support consistent adherence to safe practices. This discrepancy underscores the necessity of behavioral interventions beyond theoretical training, such as regular skills-based workshops, workplace reminders, and safety-engineered devices. Gender differences observed in the regression analysis (women showing better practices) may be related to higher representation of female nurses in direct patient care roles and potentially greater adherence to hygiene norms, consistent with some regional studies. The strong predictive role of education level further emphasizes the importance of investing in continuous professional development and higher nursing education programs in Kosovo.

Conclusion

The findings of this study highlight important insights into the knowledge and practices related to injection safety among nurses working in medical centers in Kosovo. A strong positive relationship was observed between variables, suggesting that nurses with better knowledge of injection safety are more likely to follow safe medication administration protocols. However, that association was weaker as indicating that further improvements are needed to strengthen the connection between these two aspects of infection prevention. The study also identified demographic factors influencing injection safety practices. Educational level was found to be a significant predictor of ISKP, with higher education correlating with better adherence to safety protocols. Gender differences were noted, with women exhibiting a higher level of knowledge and better practices regarding injection safety. However, age and professional experience did not show significant associations with ISKP, suggesting that factors beyond these variables may be at play in shaping safety behaviors. These findings underscore the importance of continued education, research, and interventions to improve injection safety practices among healthcare professionals.

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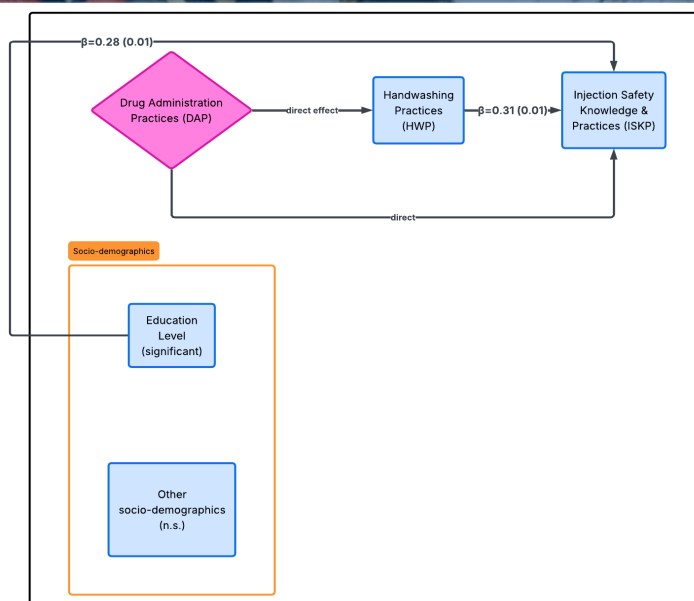


Figure 1. Analysis among variables. Term “n.s.” refers to not statistically significant.

AI statements

During the preparation of this article, the authors did not use any large language models or generative AI tools to develop the main ideas of the study.

Author's declaration

All authors contributed to the development of the research idea, data collection, statistical analysis, and preparation of the manuscript for publication.

Availability of data and materials

All data and materials used in this study were obtained from publicly available sources and are available from the corresponding author upon reasonable request.

Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence this publication.

Ethical clearance

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Publishers and journal's note

This study provides important evidence on nurses' knowledge and practices regarding injection safety in Kosovo. Its findings are relevant to nursing practice internationally, as safe injection practices remain a fundamental responsibility of nurses and other healthcare professionals in preventing avoidable harm to patients and healthcare workers. The study design was relatively straightforward, involving observations of hundreds of healthcare professionals.

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Authors' insight

Key points

- Although most nurses demonstrated good knowledge of injection safety, gaps in adherence to recommended practices highlight the need to strengthen practical implementation.
- Gender, educational level, and years of professional experience were associated with nurses' knowledge and practices, suggesting the importance of educational interventions.
- Regular training, practical workshops, and clear facility-level protocols aligned with national policies may help improve injection safety and protect both patients and healthcare workers.

Emerging nursing avenues

- What is the level of knowledge regarding injection safety to prevent infection among nurses working in medical centres in Kosovo?
- Which demographic and professional factors, including gender, educational level, and years of experience, are associated with nurses' ISKP?
- How well do nurses adhere to recommended injection safety practices, particularly regarding needle recapping and the prevention of bloodborne infections?

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