# Evaluation of the level of knowledge and compliance with standart precautions and the safety standard (NR-32) amongst physicians from a public university hospital, Brazil

# *Avaliação do nível de conhecimento e adesão às precauções-padrão e da Norma Regulamentadora (NR-32) entre os médicos de um hospital público universitário, Brasil*

**Ehideé Isabel Gómez La-Rotta**[I]
**Clerison Stelvio Garcia**[II]
**Felipe Barbosa**[III]
**Amanda Ferreira dos Santos**[IV]
**Gabriela Mazzarolo Marcondes Vieira**[IV]
**Mariângela Carneiro**[I,V]

[I]Programa de Pós-Graduação em Infectologia e Medicina Tropical da Faculdade de Medicina da Universidade Federal de Minas Gerais – Belo Horizonte (MG), Brazil.

[II]Programa de Pós-Graduação em Cirurgia da Universidade Federal de Minas Gerais – Belo Horizonte (MG), Brazil.

[III]Department of Medicine, Metrowest Medical Center – Framingham (MA), USA.

[IV]Faculdade de Medicina da Universidade Federal de Minas Gerais – Belo Horizonte (MG), Brazil.

[V]Programa de Pós-Graduação em Parasitologia do Instituto de Ciências Biológicas da Universidade Federal de Minas Gerais – Belo Horizonte (MG), Brazil.

**Corresponding author:** Ehideé Isabel Gómez La-Rotta. Universidade Estadual de Campinas. Rua Tessália Vieira de Camargo, 126, Cidade Universitária "Zeferino Vaz", CEP: 13083-887, Campinas, SP, Brasil. E-mail: eigola@hotmail.com
**Conflict of interests**: nothing to declare.

***Abstract***

Brazil is the first country in the world to have broad coverage standard (NR-32) focused on protecting health workers exposed to biological risks. This study evaluated the degree of knowledge of the NR-32 Standard and the level of knowledge and compliance with the standard precautions. A cross-sectional study was conducted with 208 randomly selected health professionals; 93 of them were residents and 115 were physicians at a Brazilian Clinical Hospital. To collect information, the participants were interviewed and/or they completed semi-structured questionnaires divided into three domains: knowledge of the standard, knowledge of biosafety, and compliance with standard precautions. Cronbach's alpha was used to assess internal consistency of the scales of knowledge and compliance with values above +0.75 indicating excellent agreement. Multivariate linear regression was used to evaluate the predictors for compliance with NR-32, biosafety, and standard precautions. Mean knowledge of the NR-32 Standard was 2.2 (± 2.02) points (minimum 0 and maximum 7 points). The minimum expected mean was 5.25 points. The mean knowledge of biosafety was 12.31 (± 2.10) points (minimum 4 and maximum16 points). The minimum expected mean was 12.75 points. The mean compliance with standard precautions was 12.79 (± 2.6) points (minimum 6 and maximum 18 points). The minimum expected mean was 13.5 points. The individual means for using gloves, masks and goggles during procedures and for not recapping needles were 2.69, 2.27, 1.20 and 2.14, respectively. The factors associated with knowledge of the NR-32 were: greater knowledge amongst those who studied at a public university and who had knowledge of biosafety. The knowledge of the NR-32 Standard was low, but there was a good level of knowledge of biosafety issues. The compliance with standard precautions was acceptable in general, but was low for some of the evaluated precautions.

**Keywords:** Government Regulation (NR-32). Universal precautions. Guideline adherence. Knowledge. Occupational health. Exposure to biological agents.

## *Resumo*

O Brasil é o primeiro país do mundo a ter uma norma de ampla abrangência (NR-32) que enfatiza a proteção dos trabalhadores de saúde expostos a riscos biológicos. Este estudo avaliou o grau de conhecimento da Norma NR-32, o nível de conhecimento e adesão às precauções padrão. Estudo transversal foi realizado com 208 profissionais selecionados aleatoriamente, sendo 93 médicos residentes e 115 médicos, em um Hospital Universitario brasileiro. As informações foram coletadas mediante entrevista e/ou preenchimento de questionário semiestruturado dividido em três domínios: conhecimentos da norma, conhecimentos em biossegurança e adesão às precauções padrão. Para avaliar a consistência interna das escalas de conhecimento e adesão, utilizou-se o alfa de Cronbach, considerando-se concordância excelente para valores maiores que +0,75. Regressão linear multivariada foi utilizada para avaliar os fatores preditores da adesão à NR-32, biossegurança e precauções padrão. A média de conhecimento sobre a Norma NR-32 foi 2,2 (± 2,02) pontos (mínimo 0 e máximo 7 pontos,). A média mínima esperada foi de 5,25 pontos. A média de conhecimento em biossegurança foi de 12,31 (± 2,10) (mínimo 4 e máximo 16 pontos). Foi esperada uma média mínima de 12,75 pontos. A média de adesão às precauções padrão foi de 12,79 (± 2,6) pontos (mínimo 6 e máximo 18). A média mínima esperada foi de 13,5 pontos. A média individual para o uso de luvas, máscara e óculos durante procedimentos e o não reecape de objetos perfurocortantes foi de 2,69, 2,27, 1,20 e 2,14, respectivamente. Os fatores associados ao conhecimento da NR-32 foram: maior conhecimento para quem estudou em universidade pública e quem tem conhecimento sobre biossegurança. O conhecimento da Norma NR-32 foi baixo, mas o nível de conhecimento em temas de biossegurança foi bom. A adesão às precauções-padrão em geral foi aceitável, mas foi baixa para algumas precauções avaliadas.



**Palavras-chave:** Regulamentação Governamental (NR-32). Precauções universais. Fidelidade a diretrizes. Conhecimento. Saúde do trabalhador. Exposição a agentes biológicos.


## Introduction

Every year, 3 million health workers around the world are at risk of acquiring illnesses through contact with micro-organisms transmitted through percutaneous blood transmission. It is estimated that 2 million professionals are at risk of acquiring hepatitis B, 900,000 of hepatitis C, and 170,000 of HIV[1].

It is currently known that needle-stick injuries are responsible for 80 to 90% of the transmission of infectious diseases amongst health workers[2]. The risk for transmission of infection by contaminated needles is 22 to 31% for Hepatitis B, 7 – 10% for Hepatitis C and 0.3% for HIV[3].

Great effort has been put into finding ways to reduce the risks for transmission of illness by means of vaccines and to protect health professionals and health service users. To this end, health professional practices have been changed to try to reduce the continuous risks to which health professional are exposed and to prevent the spread of micro-organisms[4]. However, such precautions are not always followed[5]. The high incidence of occupational accidents with exposure to biological material which has been observed could have been avoided if individual protective equipment (IPE) had been used correctly. Although using individual protection does not prevent a worker from suffering an accident, it reduces its risk[6].

It is known that compliance with precaution practices requires appropriate attitudes from health professionals over long periods of time, demanding motivation and technical knowledge from them[7]. This is an effective way to protect health professionals, patients and the public[8] and to reduce hospital infections[8,9]. Failure to comply may be reflected in high incidence rates of occupational accidents with exposure to bodily fluids and sharps[8,10-12].

Recent studies suggest that compliance with the standard precautions remains low[12-14] and there are multiple reasons for the failure to comply. The reasons include: lack

of motivation, poor technical knowledge amongst staff, insufficient training of health professionals, overwork[15,16], negative influence of inadequate behaviour by more experienced staff members[15], failure to perceive risks[4,12,17], conflicts of interest[17], lack of equipment[10,18], lack of time[18], stress[17], difficulty in adapting to use IPE[18] and perception of a lack of interest on the part of the institution for the safety of its employees[17,19].

In Brazil, it has been noted that those professionals working in health care, either directly or indirectly, are greatly concerned with patient care, but show little concern for the risks they themselves are exposed to in providing this care[12]. Amongst health workers, doctors are a group with their own specific behaviour; occupational accidents are of the order of 36%, but the true figure could be much higher as these professionals show great resistance to reporting accidents[19].

The Occupational Health and Safety in Health Service Establishments - Segurança e Saúde no Trabalho em Estabelecimentos de Assistência à Saúde (NR-32 Standard) was introduced in Brazil in 2004[20,21], making this the first country in the world to have broad coverage standards directed at health workers. The standard was created to reduce risks and to provide a healthier working environment, protecting the health of workers connected to this area[22].

The Ministry of Work and Employment (Ministério do Trabalho e Emprego – MTE) standard was published in November 2005, entering into force in April 2006, and is estimated to cover more than 1 million workers in hospitals and clinics across the country. The required inspection to control the implementation of NR-32 Standard in health services was also established[22].

The objective of the present study was to evaluate knowledge of the NR-32 Standard, biosafety, and the standard precautions and compliance with the standard precautions and to understand the factors that facilitate or undermine compliance with NR-32 and the standard precautions by physicians at the University Hospital of the Universidade Federal de Minas Gerais (HC-UFMG).

## Methods

### Study design and location

A cross-sectional study was conducted between June and October 2009, with staff from a university public general hospital, where training, research and care activities are carried out. The hospital is a reference in the municipal and state health system for provision of care to patients suffering from pathologies of medium and high complexity. It constitutes part of the Brazilian public health service (Sistema Único de Saúde – SUS), in the care of general patients. It has a total installed capacity of 501 beds, with 1,826 staff employed by the UFMG in 2008. The study was approved by the Ethical Review Board of the UFMG (nº ETIC 070/09).

### Study population and sample studied

The target population for the study was the staff of physicians at the Clinical Hospital of the UFMG who work at the institution (n = 430) and the residents (n = 353).

The Barnett formula was used to calculate the sample size[23], as the focus of the study was to estimate proportions (compliance level with the standard precautions). The parameters for the sample calculation were: universe of 783 health professionals consisting of residents (353) and pshysicians (430); maximum acceptable sample error of 0.05; estimated frequency of compliance with the standard precautions of 35%, according to international studies[10,17], and of 20%, according to the national papers[24].

The estimated sample was 208 physicians and the study involved 93 residents and 115 non-residents after considering the number of subjects in the two strata. The universe was divided into four subgroups so as to achieve a representative sample of both clinicians

and surgeons, as follows: medical (31.8%), surgeons (24%), medical residents (26.5%), and surgical residents (17.8%). The number of participants was randomly selected, respecting the proportion in each subgroup.

**Data collection**

The participants were recruited by telephone, personally and by e-mail contact and were included in the study after signing the Informed Consent Agreement. The interviews were conducted by medical students in their 4th year, who were trained using an instruction manual developed for the study. The interviews were conducted by a schedule, at the time and location most convenient to the health professional. If the participanting was not available for interviewing, the questionnaire was delivered for him/her to complete.

The information was collected through interviews and/or completion of semi-structured questionnaires comprising three domains: knowledge of the standard, knowledge of biosafety, and compliance with standard precautions. The questionnaire covered three areas: (1) information about the demographic characteristics of the participants; (2) knowledge of the health professionals about the NR-32 Standard, such as its objective, the work activities it covers and knowledge of biological risks, biosafety, standard precautions and vaccines; (3) questions to evaluate compliance with standard precautions by the health professionals, vaccination schemes, and, finally, the aspects they considered facilitated or undermined compliance with the standard and the standard precautions they include. They were also asked where they received training on biosafety, if the training was split into specialities, whether warnings were given in cases of non-compliance with the standard procedures, their perception of susceptibility, and if they had suffered any accident in their professional life.

**Statistical analysis**

The database was compiled and the statistical analysis was conducted using the Statistical Package for the Social Sciences (SPSS) software, version 12.0 (SPSS, Chicago, IL). The data was double entered and the resulting databases were compared and corrected using the EpiData software, version 3.1 (The EpiData Association, Odense, Denmark). The categorical variables were compared using $\chi^2$ test, means were compared using Student's *t*-test or analysis of variance (ANOVA), and the Kruskal-Wallis test was used to compare medians.

Cronbach's alpha test was used to assess internal consistency in the scales of knowledge. The range of interpretation of this test is: excellent agreement (values > +0.75); reasonable to good agreement (values between +0.40 and +0.74); weak agreement (values < +0.40)[25,26].

A scale was created for each domain of information collected. Points were attributed for each question in each domain. The scales ranged from 0, for poor knowledge/compliance, to 7, considered to show perfect knowledge/compliance (NR-32 Standard), 17 (biosafety) or 18 (standard precautions). To confirm whether the health professionals had good knowledge or compliance, a correct response percentage of 75% or more was considered adequate, as described by Sax et al.[15].

Multivariate linear regression analysis was used to evaluate the relationship between the scales for knowledge of the standard, for knowledge of biosafety and for standard precautions compliance and the collected co-variables (independent variables). Initially, the knowledge scale was compared with the co-variables collected using simple linear regression analysis. In this analysis, variables with a $p < 0.20$ were selected to construct the multivariate linear models. The variables that are important predictors of the analysed events according to the literature were also selected, even if they

did not meet the selection criteria ($p < 0.20$). To construct the multivariate models for each scale, the full model with all of the independent variables selected for analysis was used as a starting point and variables were successively discarded if they were not statistically significant ($p > 0.05$). The only variables remaining in the model were those statistically significant with a confidence interval of 95% and a $p < 0.05$.

## Results

### Demographic characteristics

The study evaluated 208 health professionals, in accordance with the estimated sample. To achieve this sample size, 238 health professionals were invited. Of these, 30 participants declined for lack of time as the main reason. There was no statistical difference in gender, age, and time of service between the participants who refused and those who participated. Of the participants who refused, 18 were men (60.0%) and 23 were senior medical (76.7%), with a median service time at the HC-UFMG of 1.5 years and mean of 4 ± 6.1 years.

Amongst those who participated in the study, 151 were interviewed and 57 completed questionnaires. Significant differences were found between these two groups with regard to the following variables: age, year of graduation, work experience, and years of work at the HC. These values were greater for those who completed the questionnaire and reflect the greater number of the subjects who answered the questionnaire.

Amongst the 208 study participants, the mean (standard deviation – SD) age was 33.8 (9.93); 107 (51.4%) were women, 119 (57.2%) were physicians, the median number of years of experience was 5 years, a mean of 8.99 ± 9.53 years, and the mean number of hours worked per week was 50.42 ± 21.98 hours, with a median of 60 hours (Table 1). The participants were divided into two groups, there being 93 (44.7%) residents and 115 (55.3%) physicians

The mean age, years of experience, years of service in the hospital and hours worked per week differed between the two groups ($p < 0.000$).

### Knowledge of the NR-32 Standard

The mean (SD) of knowledge of the NR-32 Standard (score from 0 to 7) was 2.20 ± 2.02. The minimum mean expected was 5.25 points. Cronbach's alpha for internal consistency was 0.836.

No statistical difference was found between the residents and the physicians with regard to the level of knowledge of the NR-32 Standard ($p = 0.620$). The overall knowledge of the majority of the items was very low, and the mean knowledge score did not differ between the subgroups ($p = 0.775$). Only 30.3% of the interviewees related knowledge of the NR-32 Standard and only 15.4% of the participants knew its objective. With regard to the activities covered by NR-32 Standard, the percentage with knowledge was less than 30%, without any difference between the groups ($p = 0.60$).

### Knowledge of biosafety

The mean of knowledge of biosafety (score from 0 to 17) was 12.31 (SD = 2.10). The minimum mean expected was 12.75 points. Cronbach's alpha was 0.532. Comparing the two groups, the mean knowledge amongst residents was 12.67 (± 1.91) and the median was 13.00; amongst the physicians, the mean was 12.03 (± 2.10) and median was 12.00. Comparing the means (Kruskal-Wallis test) resulted in a statistical difference ($p = 0.045$). No difference was found between the clinical speciality subgroups for knowledge of biosafety. When responses related to knowledge of biosafety were evaluated between the groups, no significant statistical difference was found in the majority of the cases. The difference between the groups was statistically significant ($p > 0.05$) in responses about standard precautions

**Table 1 - Demographic characteristic among physician and residents, Public Hospital, Brazil, 2009.**
***Tabela 1 - Características demográficas entre os residentes e médicos, Hospital Publico, Brasil, 2009.***

| Characteristics | Residents n = 93 | Physicians n = 115 | p-value* |
|---|---|---|---|
| Gender | | | |
| Female (%) | 48 (51.6) | 59 (51.3) | 0.965 |
| Male (%) | 45 (48.4) | 56 (48.7) | |
| Age | | | |
| Medians (IQR 25;75) | 27 (26; 29) | 35 (31; 43) | 0.000 |
| Means ± SD | 27.3 ± 2.5 | 38.7 ± 10.1 | |
| Marital status | | | |
| Single (%) | 76 (81.7) | 28 (24.3) | 0.000 |
| Married (%) | 16 (17.2) | 78 (67.8) | |
| Separed/divorced (%) | 1 (1.1) | 9 (7.8) | |
| Type of specialization | | | |
| Clinical (%) | 56 (60.2) | 68 (59.1) | 0.874 |
| Surgical (%) | 37 (39.8) | 47 (40.9) | |
| Year of graduation | | | |
| Before 2005 (%) | 30 (32.3) | 108 (93.9) | 0.000 |
| After 2005 (%) | 63 (67.7) | 7 (6.1) | |
| University of graduation | | | |
| Public (%) | 78 (83.9) | 101 (87.7) | 0.414 |
| Private (%) | 15 (16.1) | 14 (12.2) | |
| Years of professional | | | |
| Medians (IQR) | 2 (1; 3.5) | 11 (6; 19) | 0.000 |
| Means ± SD | 2.73 ± 2.1 | 14.1 ± 10.2 | |
| Years of service at HC-UFMG | | | |
| Medians (IQR) | 0 (0; 1) | 4 (2; 9) | 0.000 |
| Means ± SD | 0.74 ± 0.9 | 6.43 ± 7.5 | |
| Work hours per week at HC-UFMG | | | |
| Medians (IQR) | 60 (55; 75) | 40 (20; 60) | 0.000 |
| Means ± SD | 61.97 ± 15.6 | 41.08 ± 22.0 | |

*p-value for $\chi^2$ for proportions, Student's *t*-test for means and Kruskal-Wallis test for medians.
IQR: inter quatille range; SD: standard deviation; HC-UFMG: Clinical Hospital of the Universidade Federal de Minas Gerais.
*valor p para a comparação de proporções com o $\chi 2$ ,de medias com o teste de t-student, e, para medianas com o teste de Kruskal-Wallis.
Quartis 25-75; DP: desvio padrão; HC-UFMG: Hospital das Clinicas da Universidade Federal de Minas Gerais

concerning handling contaminated material with care and precautions relating to fluids and blood; 100% of the residents knew that there are standard precautions in these two areas, whereas the proportion of the physicians was 89.6 and 92%. The participants acquired knowledge of biosafety during their undergraduate education (52.4%), through training at HC-UFMG (30.4%), by reading (22.1%), and in graduate courses (17.8%).

**Compliance with standard precautions**

The mean (SD) score (score from 0 to 18) related to compliance with standard procedures was 12.79 (± 2.6) and the median was 13.00. The minimum expected mean was 13.5 points. There was no difference (p = 0.316) between the mean values for compliance with the standard precautions between the physicians (12.96 ± 2.9) and the residents (12.57 ± 2.31). Cronbach's alpha for internal consistency was 0.446.

The mean values for individual items were: 2.69 for the use of gloves, 2.27 for the use of masks, 1.20 for the use of goggles during procedures with a risk of contact with secretions either directly or through splashing; 2.14 for not recapping needles after use. The mean for removing white coats on leaving the hospital was 2.09.

**Table 2 –** Factors associated with the scale of knowledge of the NR-32 Standard. Public Hospital, Brazil, 2009.
***Tabela 2 –*** *Fatores associados à escala de conhecimento da Norma Regulamentadora NR-32. Hospital Público, Brasil, 2009.*

| Variables | Univariate analysis | | | Multivariate analysis | | | |
|---|---|---|---|---|---|---|---|
| | β | SE | p-value* | adjβ | SE | 95%CI | p-value* |
| Age (years) | | | | | | | |
| 20 – 29 | 0 | | | | | | |
| 30 – 39 | -0.794 | 0.324 | 0.014 | | | | |
| 40 – 49 | -0.051 | 0.395 | 0.898 | | | | |
| > 50 | 0.067 | 0.535 | 0.900 | | | | |
| University of graduation | | | | | | | |
| Public | 0 | | | | | | |
| Private | -1.071 | 0.3970 | 0.007 | -1.022 | 0.395 | -1.7 to -0.2 | 0.009 |
| Years of service at HC-UFMG | 0.029 | -0.022 | 0.197 | | | | |
| Perception of susceptibility | | | | | | | |
| Yes | 0 | | | | | | |
| No | -0.431 | 0.386 | 0.265 | | | | |
| Scale of knowledge of biosafety | 0.187 | 0.066 | 0.005 | 0.041 | 0.021 | 0.04 to 1.19 | 0.034 |
| Scale of compliance with standard precautions | 0.097 | 0.064 | 0.134 | | | | |

SE: standard error; adj: adjusted; CI: confidence interval; HC-UFMG: Clinical Hospital of the Universidade Federal de Minas Gerais.
ES: erro estandar; adj: adjustada; CI: intervalo de confiança; HC-UFMG: Hospital das Clínicas da Universidade Federal de Minas Gerais

The expected mean for these values was 2.25 points (score between 0 and 3).

The percentages for the responses about vaccination were compared between the two groups and it was found that a greater percentage of the residents had been vaccinated against tetanus, diphtheria, MMR and tuberculosis ($p < 0.005$). In addition, a difference was found in the number of (65.2%) who washed their hands after coming into contact with secretions compared with residents (48.4%) ($p < 0.005$). Finally, with regard to removing white coats when leaving the hospital, the greatest proportion ($p < 0.005$) of who said that did so was amongst the physicians (56.5%) compared to the residents (40.9%). Hepatitis B vaccine was taken by 100% of the residents and by 98.2% of the physicians.

**Factors that facilitate and undermine compliance with the standard precautions**

The most commonly cited factors for improving compliance with the standard precautions and the NR-32 Standard were capacity building and regular and continuous training (42.8%), information, particularly on posters and notices (29.8%), availability (21.6%) and access (11.1%) to IPE items, particularly masks and goggles. Other factors that participants considered to be fundamental included knowledge of the NR-32 Standard (8.2%), continuous monitoring of staff (7.7%), and continuous direction on the theme for the instructors, the Hospital Infection Control Committee (HICC) health professionals and the members of the Occupational Health Department of the Clinical Hospital of UFMG (6.7%). One factor as important as the above, though little cited by the participants, is hospital infrastructure (3.4%), including the presence of pedal sinks in all rooms, with soap and disposable paper towels constantly available in work locations. The factors that undermine compliance with the standard precautions include the lack of availability of material (51.4%), overwork (18.3%), haste (16.8%) and poor access to IPE (13.5%).

**Knowledge of the NR-32 Standard**

The following predictor variables were found to be factors associated with the level of knowledge: the university where the health professional graduated and knowledge of biosafety. Those who studied at a private university had less knowledge of the NR-32 Standard (β: -1.022; 95%CI -1.793 to -0.251; p < 0.009); those who had better knowledge of biosafety had better knowledge of the NR-32 Standard (β: 0.623; 95%CI: 0.046 to 1.199; p < 0.034) (Table 2).

**Compliance with the standard precautions**

In the multiple linear regression model, only marital state (β: -2.113; 95%CI -3.511 to -0,714; p < 0.03) was associated with the level of compliance with the standard precautions. Married professionals showed better compliance than single ones.

**Knowledge of biosafety**

In the multiple linear regression model, age (β: -0.33; 95%CI -0.062 to -0.004), training at the hospital (β: -0.967; 95%CI -1.521 to -0.414) and knowledge of the NR-32 Standard (β: 0.198; 95%CI 0.064 to 0.333) were factors associated with the level of knowledge of biosafety. Participants who received training at the hospital had better knowledge of the themes, which also correlated with knowledge of the Standard and of biosafety. However, knowledge decreased with age. As age and years of work experience were highly correlated, only age was included (Table 3).

## Discussion

The results found in the present study show that the level of knowledge about NR-32 is low amongst the medical staff at the Clinical Hospital. The mean of knowledge was 2.20 ± 2.02 points, with a mean of 5.25 being expected. These are important results as, until now, there have been no studies about institutional compliance with NR-32 and health professionals' knowledge of it.

With regard to biosafety, the scores for the responses in the present study varied from 4 to 16, with a mean of 12.31 ± 2.10, with an expectation of 12.75 (75% correct responses)[15]. It can be concluded that the level of knowledge amongst the study participants was adequate. These findings are similar to those of studies conducted in Brazil and in other countries, which found similar mean values for knowledge. A study conducted in Iran found that the mean knowledge scores amongst physicians and residents varied between 6 and 7 (66.6 – 77.7%). A high level of knowledge was found because at least six of the nine questions were answered correctly by 75% of the doctors in each group[27]. Another study, also conducted in Iran by Askarian et al. with medical students, found that the mean knowledge amongst the participants was 6.09 ± 1.51, suggesting that the level of knowledge about the standard precautions is acceptable. However, the mean score for knowledge amongst the students in their fifth year (5.74 ± 1.92) was statistically less than amongst the students in their sixth year (6.18 ± 1.36) and seventh year (6.21 ± 1.31)[11]. A study conducted in Brazil found that 55.9% of the health professionals gave correct responses to 10 or more of the 13 knowledge questions. The mean score was 9.7 ± 1.9[15].

In the present study, analysis of compliance of health professionals with standard procedures (SP) took the following factors into account: (1) Hepatitis B vaccination; (2) washing hands before and after patient care, before and after using gloves, and when unwanted contact with blood, body fluids, excretions and contaminated items had occurred; (3) use of IPE (gloves, mask and goggles); and (4) needle recapping. Responses varied between 6 and 18 points with a mean of 12.79 ± 2.6 points. The expected value was 13.5 points (75% correct responses). It can be concluded that the level of compliance with the standard precautions is moderate. This level of compliance

**Table 3 –** Factors associated with the scale of knowledge of biosafety, Clinical Hospital, Brazil, 2009.
***Tabela 3 –*** *Fatores associados à escala de conhecimento em biossegurança, Hospital Público, Brasil, 2009.*

| Characteristics | Univariate analysis | | | Multivariate analysis | | | |
|---|---|---|---|---|---|---|---|
| | β | SE | p-value | adjβ | SE | 95%CI | p-value |
| Age (years) | -0.004 | 0.015 | 0.010 | -0.32 | 0.015 | -0.061 to -0.002 | 0.034 |
| Age (years) | | | | | | | |
| 20 – 29 | 0 | | | | | | |
| 30 – 39 | -0.455 | 0.333 | 0.173 | | | | |
| 40 – 49 | -0.207 | 0.407 | 0.611 | | | | |
| > 50 | -1.806 | 0.551 | 0.001 | | | | |
| Level of medical practitioner | | | | | | | |
| Residents | 0 | | | | | | |
| Physician | -0.641 | 0.289 | 0.027 | | | | |
| Year of graduation | | | | | | | |
| Before 2005 | 0 | | | | | | |
| After 2005 | 0.498 | 0.305 | 0.103 | | | | |
| University of graduation | | | | | | | |
| Public | 0 | | | | | | |
| Private | -0.523 | 0.4182 | 0.211 | | | | |
| Years of professional experience | -0.037 | 0.015 | 0.015 | | | | |
| Years of service at HC-UFMG | -0.041 | -0.023 | 0.079 | | | | |
| In-hospital training | | | | | | | |
| Yes | 0 | | | | | | |
| No | -1.085 | 0.283 | 0.000 | -0.994 | 0.283 | -1.550 to -0.438 | 0.000 |
| Perception of susceptibility | | | | | | | |
| Yes | 0 | | | | | | |
| No | -0.451 | 0.402 | 0.262 | | | | |
| Scale of compliance with standart precautions | 0.057 | 0.064 | 0.371 | | | | |

SE: standard error; adj: adjusted; CI: confidence interval; HC-UFMG: Clinical Hospital of the Universidade Federal de Minas Gerais.
ES: erro estandar; adj: adjustada; CI: intervalo de confiança; HC-UFMG: Hospital das Clínicas da Universidade Federal de Minas Gerais

puts the participants at risk because contact with any patient may result in occupational transmission of nosocomial infections, but the combined use of the methods increases protection and inversely reduces risk. From the evaluation of each of the precautions it can be seen that 97.7% of the physicians took the full course of vaccination against Hepatitis B, but of these, only 41.9% made anti-HBs. This result is adequate when compared with the findings of Ciorlia and Zanetta[28], who found 73.5%, and Carvalho[29], who found 50% amongst nurses. A study conducted in Iran found that complete vaccination against hepatitis B was done on 88.1% of the participants. Merely 60% of the participants (210 cases) had checked their hepatitis B surface antibody (anti-HBs) level, of whom 83.8% were positive[30].

Amongst the study participants, the constant use of gloves, masks and goggles when necessary was 75.6, 56.3 and 17.2%, respectively. This shows a good use of gloves by the physicians in the present study, when compared to other studies. Other studies found 66%[31], and 35%[10] of physicians reported using gloves in invasive procedures. With regard to compliance with the use of masks and goggles, the findings are also similar to published results. Gammon and Gould analysed the literature concerning compliance with standard precautions and found that the majority of study authors state that compliance with the use of goggles is very low, while the use of masks is acceptable[32]. This was corroborated in the study by Pereira et al., who found use amongst anaesthetists was 85.7% for gloves, 100% for masks, but 0% for goggles[33].

In relation to washing hands before and after patient care, it was found percentages are higher than 80% which is considered to

be a good achievement, but in the case of washing hands before and after using gloves, and regarding the contact with secretions, we found 34.6, 65.3 and 57.6%, respectively, which were lower than expected. This was corroborated in the study by Askarian et al., who found 41.2% had used the correct practice to wash hands before and after using gloves. But, by the other way he found that only one of the items of the precautions standard, which is hand washing after touching contaminated items, was always practiced by 75.6% to 100% of the practitioners[5].

Only 49.5% of physicians reported that they always removed their white coats on leaving the hospital. In addition, 10.1% of doctors never use a white coat in the hospital or clinic. The standards are clear on the use of clothing by health professionals: "Workers must not leave the workplace with individual protective equipment and the clothing used during their work activities"[21].

It is noteworthy that 52.6% of doctors recap needles. Reda found that 73.3% of participants physicians recapped needles after use the majority of times, noting that the recommendation to not recap needles is not followed by the majority of health professionals[34]. Another study reports that few physicians responded correctly (27.8% of doctors and 55.6% of residents) that needles should be neither recapped nor bent[27]. Only 34.6% of physicians wash their hands before using gloves, similar to the findings of Askarian et al.[5], as less than three quarters of the residents knew that they have to wash their hands before using gloves.

Amongst the factors found to be associated with good knowledge of the NR-32 Standard are: the university where the physician was educated and the level of knowledge of biosafety. The physicians graduating from public universities and with a higher level of knowledge showed better knowledge of NR-32. It can be concluded that although little known, the physicians with good knowledge of biosafety themes, also know the standards, even if not completely. Those who know the Standard usually graduated from federal a public university, which suggests that these themes are part of the curricula of federal universities.

The level of knowledge about biosafety was good, and the factors found to contribute to this included the doctors' age and in-hospital training. Younger health workers had better knowledge, this factor being associated with the in-hospital training. As described previously, another factor is knowledge of the standards. Those familiar with NR-32 have good knowledge of biosafety and vice-versa. Another variable associated with the level of knowledge is the amount of professional experience, which was removed from the multiple regression due to its high correlation with age. Studies conducted with doctors also found good predictors of knowledge to be years of experience and workplace training[15].

Marital status was among the factors associated with compliance with the universal precautions. Married doctors show better compliance with the SP than single professionals. The marital status variable is probably a proxy variable for the time since graduation. A study conducted in Pakistan found predictors for compliance with SP were knowledge of the transmission of infections diseases through blood contact, and years of experience[35]. Other studies have also found an inverse relationship between the level of compliance and the years since graduation[36]. A study by Henry et al. evaluated compliance with each IPE item and found that age was negatively associated with the use of masks and overcoats[37].

Amongst the limitations of this study, it is noted that, because it used cross-sectional study method, the conclusions about the temporal nature of the associations are limited. In the data collection, it was found that some health professionals lack time to respond to the questionnaire in the presence of the interviewer, which is a common problem in public university hospitals, making it necessary to deliver the form and collect it later. Comparison of the two groups, of interviewees and respondents (without the presence of an interviewer), shows that the participants who responded to the questionnaire had higher means and medians

with regard to age, time since graduation, experience, work in the HC-UFMG and hours worked per week. These differences suggest that physicians were less available than residents. There was no difference between the groups in the scale of knowledge of the NR-32 Standard (p = 0.862) and the scale of compliance with the standard precautions (p = 0.114). However, in the scale of knowledge of biosafety, a lower level of knowledge was found amongst those who completed the form compared with those who were interviewed (p = 0.005). This fact corroborates the greater percentage of doctors who completed the questionnaire and who have a lower level of knowledge of the Standard, as found in the multivariate analysis. The questionnaire used to collect data was structured based on the Technical Guide of Biological Hazards – Biological Risks in the context of the safety standard (NR-32). It was performed a pilot study and peer review. In addition it was performed Cronbach's alpha test that was used to assess internal consistency in the scales; but we find values between +0.40 and +0.74 for scales of knowledge of biosafety and adherence to standard precautions, which is reasonable according to the literature. Before these results, we can consider that the lack of consistency in the scales is that the instrument does not fully portray the construct; this is being a limitation for this study.

In conclusion, the physicians are not familiar with NR-32. The knowledge that participants in the study have of biosafety, biological risk and standard precautions is high. Compliance with the standard precautions is acceptable, but insufficient to provide the health professionals with total protection against biological risks. Age and years of experience are conditional factors for achieving good compliance with biossecurity.

## Acknowledgments

To the University Hospital of the Universidade Federal de Minas Gerais for cooperation. The Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) granted a scholarship to E.I.G.L. Rotta (Master Degree, Programa de Pós-Graduação em Ciências da Saúde: Infectologia e Medicina Tropical). M. Carneiro is a Research Fellow from CNPq and the Fundação de Amparo à Pesquisa de Minas Gerais (FAPEMIG-Pesquisador Mineiro).

## References

1. Hutin YJ, Hauri AM, Armstrong GL. Use of injections in healthcare settings worldwide, 2000: literature review and regional estimates. BMJ 2003; 327(7423): 1075.

2. Siegel JD, Rhinehart E, Jackson M, Chiarello L; Health Care Infection Control Practices Advisory Committee. 2007 Guideline for isolation precautions: preventing transmission of infectious agents in health care settings. AmJ Infect Control 2007; 35(2): 65.

3. Ayliffe G, Geddes M. Serviços de saúde ocupacional no controle de infecção. In: Ayliffe GAJ. Controle de infecção hospitalar: manual prático. Rio de Janeiro: Revinter; 2004.

4. Gir E, Takahashi RF, de Oliveira MA, Nichiata LY, Ciosaks SI. Biosafety in STD/AIDS: conditioning factors of nursing workers' adherence to precaution measures. Rev Esc Enferm USP 2004; 38(3): 245-53.

5. Askarian M, McLaws ML, Meylan M. Knowledge, attitude, and practices related to standard precautions of surgeons and physicians in university-affiliated hospitals of Shiraz, Iran. Int J Infect Dis 2007; 11(3): 213-9.

6. Brevidelli MM, Cianciarullo TI. Compliance with standard-precautions among medical and nursing staff at a university hospital Brazilian. Online Braz J Nurs 2006; 5(2).

7. Roberts C. Universal precautions: improving the knowledge of trained nurses. Br J Nurs 2000; 9(1): 43-7.

8. Ferguson J. Preventing healthcare-associated infection: risks, healthcare systems and behaviour. Intern Med J 2009; 39(9): 574-81.

9. Arenas Jiménez MD, Sánchez-Payá J. Standard precautions in haemodialysis--the gap between theory and practice. Nephrol Dial Transplant 1999; 14(4): 823-5.

10. Nelsing S, Nielsen TL, Brønnum-Hansen H, Nielsen JO. Incidence and risk factors of occupational blood exposure: A nation-wide survey among Danish doctors. Eur J Epidemiol 1997; 13(1): 1-8.

11. Askarian M, Honarvar B, Tabatabaee HR, Assadian O. Knowledge, practice and attitude towards standard isolation precautions in Iranian medical students. J Hosp Infect 2004; 58(4): 292-6.

12. Brevidelli MM, Cianciarullo TI. Application of the health belief model to the prevention of occupational needle accidents. Rev Saude Publica 2001; 35(2): 193-201.

13. Allegranzi B, Pittet D. Role of hand hygiene in healthcare-associated infection prevention. J Hosp Infect 2009; 73(4): 305-15.

14. Cavalcante NJF, Monteiro ALC, Barbieri DD. Biossegurança: atualidades em DST/AIDS; 2003. Disponível em: http://bvsms.saude.gov.br/bvs/publicacoes/08bioseguranca.pdf (Acessado em 24 de novembro de 2013).

15. Sax H, Perneger T, Hugonnet S, Herrault P, Chraïti MN, Pittet D. Knowledge of standard and isolation precautions in a large teaching hospital. Infect Control Hosp Epidemiol 2005; 26(3): 298-304.

16. Lopes ACS, Oliveira AC, Silva JT, Paiva MH. Adesão às precauções padrão pela equipe do atendimento pré-hospitalar móvel de Belo Horizonte, Minas Gerais, Brasil. Cad Saúde Pública 2008; 24(6): 1387-96.

17. Gershon RRM, Vlahov D, Felknor SA, Vesley D, Johnson PC, Delclos GL. Compliance with universal precautions among health care workers at three regional hospitals. Am J Infect Control 1995; 23(4): 225-36.

18. Florêncio V, Rodrigues CA, Pereira MS, Souza ACS. Adesão às precauções padrão entre os profissionais da equipe de resgate pré-hospitalar do Corpo de Bombeiros de Goiás. Rev Eletrônica Enferm 2003; 5(1): 43-8.

19. Cocolo AC. Equipes médicas e de enfermagem menosprezam risco de acidentes. Departamento de Comunicação Institucional da UNIFESP. 2005. Disponível em: http://dgi.unifesp.br/sites/comunicacao/index.php?c=Noticia&m=ler&cod=498fe4fe (Acessado em 26 de novembro de 2013).

20. Brasil. Ministério do Trabalho e Emprego. Segurança e Saúde no Trabalho em Estabelecimentos de Assistência à Saúde. Portaria nº 485, de 11 de Novembro de 2005. Brasília: Ministério do Trabalho e Emprego; 2005.

21. Brasil. Ministério do Trabalho e Emprego. Riscos biológicos: Guia Técnico. Os riscos biológicos no âmbito da Norma Regulamentadora nº 32. Brasília: Ministério do Trabalho e Emprego; 2005. p. 1-66.

22. Rapparini CS. Riscos biológicos e seguranca dos profissionais de saúde. Infectologia Hoje 2006; 1(2): 1-2.

23. Couto A, Abreu A. Estatística aplicada ao controle das infecções hospitalares. In: Couto RM, Pedrosa TMG, Nogueira JM, editors. Infecção hospitalar e outras complicações não-infecciosas da doença. Epidemiologia, controle e tratamento. Rio de Janeiro: MEDSI; 2005. p. 169-202.

24. Pinheiro J, Zeitoune R. Hepatite B: conhecimento e medidas de biossegurança e a saúde do trabalhador de enfermagem. Esc Anna Nery Rev Enferm 2008; 12(2): 258-64.

25. Batista-Foguet JM, Coenders G, Alonso J. Análisis factorial confirmatorio. Su utilidad en la validación de cuestionarios relacionados con la salud. Med Clin 2004; 122(Suppl 1): 21-7.

26. Gliem JA, Gliem RR. Calculating, interpreting, and reporting Cronbach's alpha reliability coefficient for Likert-type scales. In: Midwest Research to Practice Conference in Adult, Continuing, and Community Education; 2003. p. 87.

27. Askarian M, Kabir G, Aminbaig M, Memish ZA, Jafari P. Knowledge, attitudes, and practices of food service staff regarding food hygiene in Shiraz, Iran. Infect Control Hosp Epidemiol 2004; 25(1): 16-20.

28. Ciorlia LA, Zanetta DM. Hepatitis C in health care professionals: prevalence and association with risk factors. Rev Saude Publica 2007; 41(2): 229-35.

29. Carvalho SF. Adesão dos trabalhadores de enfermagem à vacina contra hepatite B [dissertação de mestrado]. Rio de Janeiro: Escola de Enfermagem da Universidade Federal do Estado do Rio de Janeiro; 2004.

30. Kabir A, Tabatabaei SV, Khaleghi S, Agah S, Kashani AH, Moghimi M, et al. Knowledge, attitudes and practice of Iranian medical specialists regarding hepatitis B and C. Hepat Mon 2010; 10(3): 176-82.

31. Doebbeling BN, Vaughn TE, McCoy KD, Beekmann SE, Woolson RF, Ferguson KJ, et al. Percutaneous injury, blood exposure, and adherence to standard precautions: are hospital-based health care providers still at risk? Clin Infect Dis 2003; 37(8): 1006-13.

32. Gammon J, Gould D. Universal precautions: a review of knowledge, compliance and strategies to improve practice. J Res Nurs 2005; 10(5): 529-47.

33. Pereira TM, Castro KF, Santos TO, Prado MA, Junqueira ALN, Barbosa MA, et al. Evaluation of the pattern safety adoption by health professional specific categories. Rev Eletr Enf [Internet] 2006; 10(1).

34. Reda AA, Fisseha S, Mengistie B, Vandeweerd JM. Standard precautions: occupational exposure and behavior of health care workers in Ethiopia. PLoS One 2010; 5(12): e14420.

35. Janjua NZ, Razaq M, Chandir S, Rozi S, Mahmood B. Poor knowledge--predictor of nonadherence to universal precautions for blood borne pathogens at first level care facilities in Pakistan. BMC Infect Dis 2007; 7: 81.

36. Helfgott AW, Taylor-Burton J, Garcini FJ, Eriksen NL, Grimes R. Compliance with universal precautions: knowledge and behaivor of residents and students in a department of obstretics and gynecology. Infect Dis Obstet Gynecol 1998; 6(3): 123-8.

37. Henry K, Campbell S, Collier P, Williams CO. Compliance with universal precautions and needle handling and disposal practices among emergency department staff at two community hospitals. Am J Infect Control 1994; 22(3): 129-37.

Received on: 12/01/11
Final version persented on: 10/22/12
Accepted on: 03/07/13