Infectious diseases in healthcare workers – an analysis of the standardised data set of a German compensation board

Albert Nienhaus¹,²*, Chandrasekharan Kesavachandran¹, Dana Wendeler², Frank Haamann² and Madeleine Dulon²

Abstract

Introduction: Healthcare workers (HCW) are exposed to infectious agents. Disease surveillance is therefore needed in order to foster prevention.

Methods: The data of the compensation board that covers HCWs of non-governmental healthcare providers in Germany was analysed for a five-year period. For hepatitis B virus (HBV) and hepatitis C virus (HCV) infections, the period analysed was extended to the last 15 years. The annual rate of occupational infectious diseases (OIDs) per 100,000 employees was calculated. For needlestick injuries (NSI) a rate per 1,000 employees was calculated.

Results: Within the five years from 2005 to 2009 a total of 384 HCV infections were recognised as OIDs (1.5/100,000 employees). Active TB was the second most frequent cause of an OID. While the numbers of HBV and HCV infections decreased, the numbers for active TB did not follow a clear pattern. Needlestick injuries (NSIs) were reported especially often at hospitals (29.9/1,000 versus 7.4/1,000 employees for all other HCWs).

Conclusion: Although they are declining, HCV infections remain frequent in HCWs, as do NSIs. Whether the reinforcement of the recommendations for the use of safety devices in Germany will prevent NSIs and therefore HCV infections should be closely observed.

Keywords: Healthcare workers, Infections, Tuberculosis, Needlestick injuries, Blood-borne virus infections

Introduction

It is well known that healthcare workers (HCWs) risk contracting infectious diseases [1]. HCWs are at risk of infection with blood-borne pathogens during occupational exposure to blood and body fluids [2]. The increased risk of tuberculosis (TB) infection for HCWs is well documented [3-5]. Emerging infectious diseases such as severe acute respiratory syndrome (SARS), H5/N1 avian influenza and H1/N1 swine influenza have shown the particular vulnerability of HCWs. SARS was identified as a new disease by WHO physician Dr. Carlo Urbani. He diagnosed it in a patient who died from the illness. Dr. Urbani subsequently died from SARS, too. SARS affected 8,096 individuals globally, 21% of whom were HCWs [6,7]. SARS has been known to spread extensively among HCWs in various settings. In outbreaks in Hong Kong and Toronto, 62% [8] and 51% [9] of the infected patients were HCWs.

During the first outbreak of H5/N1 avian infections in Hong Kong in 1997, the prevalence of H5/N1 antibodies was five times higher in exposed HCWs than in HCWs without contact to avian influenza patients, i.e. 3.7% (8/217) versus 0.7% (2/309) [10]. Even though H1/N1 swine influenza was well contained in Portugal, HCWs were at increased risk of contracting this infection [11]. The increased risk of infection for HCWs is not always easy to detect. Working in healthcare was for a long time considered a safe place offering protection against tuberculosis. Only when the prevalence of tuberculosis declined in the general population did it become apparent that the rate of latent tuberculosis infection (LTBI) and active tuberculosis was high in those caring for tuberculosis patients [12]. With the further decline of tuberculosis in
high-income countries, interest in tuberculosis as an occupational disease dwindled. It was only with the emergence of HIV that interest in tuberculosis as a co-infection inspired research and fostered the prevention of infectious diseases in HCWs. In the aftermath of the HIV emergence, awareness of accidental blood contact and needlestick injuries rose, leading finally to the Needlestick Safety and Prevention Act in the US [13] and to the mandatory introduction of safety devices in Germany (TRBA 250 [14]) in order to prevent needlestick and sharps injuries as well as blood contact between patients and HCWs.

Surveillance data on occupational health risks is a cornerstone in occupational safety and health (OSH) management. Therefore new members of the enlarged European Union (EU) were encouraged to adopt the EU’s list of occupational diseases (ODs) and to build up their own monitoring system for surveying the burden of ODs in their countries [15]. Reporting the data on claims of occupational infectious diseases (OIDs) filed by HCWs with the compensation board not only sheds light on important time trends in workplace-related health risks, but also stresses the importance of workplace prevention and hygiene. This type of surveillance system can be adopted by other countries with evolving social security systems in order to reduce the disease burden in HCWs [16].

Even though hygiene standards are high and access to vaccination is comprehensive in high-income countries like Germany, HCWs still remain vulnerable to infections at their workplaces. The aim of our study was to describe the number of infectious diseases in HCWs and to describe time trends using the standardised database of a compensation board.

Methods
The Berufsgenossenschaft for the healthcare (Gesundheitswesen) and welfare services (BGW) (Institution for Statutory Accident Insurance and Prevention) is the compensation board for all non-governmental healthcare and welfare providers in Germany. A total of 500,000 enterprises with about six million paid workers are covered by the BGW. The BGW’s database on compensation claims concerning the occupational disease number 3101, “infectious disease with human-to-human transmission”, was used for this analysis. The database allows a distinction to be made between the most frequent infectious diseases. Furthermore accidental blood contact reported to the compensation board can be identified. Contact with blood (or other body fluids) splashed onto the skin or the mucous membranes is coded as accidental blood contact (ABC). No information is available on whether the ABC occurred on intact or non-intact skin or on skin or mucous membranes.

Injuries caused by used needles, scalpels or knives are coded as needlestick injuries (NSIs).

The reporting of suspected cases of ODs is compulsory for physicians and companies after first diagnosis. In the standardised data set, a further distinction is made between ODs that are mandatorily reportable and those that are not. Reporting ABC is not mandatory. ABC in the form of splashes is documented as an OID. It is reported to the compensation board because the cost of post-exposure prevention is covered by the board. NSIs are documented as working accidents. They must only be reported if they cause sick leave of more than three days, which they do not normally. However, they are reported in order to obtain compensation for the cost of post-exposure prevention independent of any sick leave.

The distinction between infectious diseases was introduced at different times and is available only for the most important infectious diseases. Claims of OIDs were analysed for 2009. Time trends over five years were analysed for claims concerning tuberculosis (TB), latent tuberculosis infection (LTBI), scabies, methicillin-resistant Staphylococcus aureus (MRSA), human immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS), ABC and NSIs. As the data set allows a distinction to be made between hepatitis B virus (HBV) and hepatitis C virus (HCV) starting in 1995, time trends are given for the 15 years between 1995 and 2009 for these infections. LTBI was considered present if the interferon-γ release assay (IGRA) was positive and active TB was excluded by X-ray.

We calculated rates of OIDs per 100,000 employees and of NSIs and ABC per 1,000 employees. In order to reduce variation by chance, these rates were calculated as an average for the last five years.

The prevalence of OIDs, ABCs and NSI were analysed for selected working areas in healthcare. These working areas correspond to clustered occupational groups, including settings with comparable risks of accidents and diseases, which are used in combination with compensation money to calculate insurance premiums. For the analyses, four working areas were selected: 1.) hospitals and other clinical facilities (referred to as hospitals in the following), 2.) medical surgeries with all kind of specialisations (referred to as surgeries), 3.) nursing homes, hospices, and other long-term care facilities (referred to as nursing homes), 4.) outpatient medical and social care, emergency medical services (referred to as outpatient care). The remaining occupational groups — including veterinary practices, hairdressing, administration, day care, social welfare services and facilities for the handicapped — were pooled (referred to as others in the following). Five-year trends for the most frequent infectious diseases were analysed separately for these working areas. Regulations for using safety devices were bolstered in Germany in 2008. Therefore claims of NSIs and ABC were analysed depending on...
working areas for 2008 and 2009 in order to see whether the new regulations had decreased the number of NSIs or ABC in the different working areas. Costs for NSIs and ABC were extracted from the data set for a five-year period.

Results
A total of 3,008 infections were claimed in 2009 (Table 1). The bulk of them were not mandatorily reportable (69%). Scabies was the most frequent cause of a claim (38%). However, most of these claims were not reportable contacts (90%) and not actual infections with scabies. The second most frequent cause of a claim was tuberculosis (26%). Again, most often these claims concerned notifications of contact with infectious patients or materials (60%) and were therefore not reportable. Influenza (9%) and MRSA (8%) followed thereafter, with less than 10% of the claims. Again, most claims concerned infectious contact rather than actual infections. Ten percent of all claims were claims due to hepatitis virus infections. However, two-thirds of these claims were mandatory (62%). HCV was the most frequent claim here, followed by HBV. Less than 1% of the claims related to HIV/AIDS. In addition to the blood-borne virus infection claims, in 2009 a total of 2,991 cases of ABC and 39,919 NSIs were reported (Figures 1 and 2).

Over the last 15 years the number of reportable claims of suspected OIDs has declined along with the number of HBV and HCV infections recognised as OIDs (Figure 3). While claims for HCV infections increased from 1995 to 2002, followed by a sharp decrease thereafter, a continuous decrease for HBV infections was observed starting in 1995. The number of recognised HCV cases only started to decline after 2005, while for HBV a decrease was seen over the whole period again. These temporal trends are not confirmed by reports of ABC or NSIs. Reports of ABC increased from 2,143 in 2005 to 2,991 in 2009 (Figure 1). Reports of NSIs increased from 2005 until 2009 by 2% to 5% annually (Figure 2, Table 2).

Table 1 Number of suspected cases of occupational infectious diseases (OD no. 3101) for 2009 separated by notification requirement, data from BGW, German

| Occupational infectious diseases (OD no. 3101)          | Mandatory | Not mandatory | Total (col %) |
|-------------------------------------------------------|-----------|---------------|---------------|
|                                                       | N (row %) | N (row %)     |               |
| Tuberculosis (TB)                                      | 311 (40)  | 472 (60)      | 783 (26)      |
| Hepatitis virus infection (total)                      | 181 (62)  | 113 (38)      | 294 (10)      |
| Thereof                                               |           |               |               |
| A                                                     | 4 (57)    | 3 (43)        | 7 (<1)        |
| B                                                     | 75 (60)   | 50 (40)       | 125 (4)       |
| C                                                     | 101 (64)  | 58 (36)       | 159 (5)       |
| D                                                     | 0         | 0             | 0             |
| E                                                     | 1 (33)    | 2 (67)        | 3 (<1)        |
| Scabies                                               | 110 (10)  | 1,026 (90)    | 1,136 (38)    |
| MRSA/ORSA                                             | 102 (44)  | 128 (56)      | 230 (8)       |
| Influenza                                             | 53 (21)   | 206 (79)      | 259 (9)       |
| Angina/pertussis                                      | 27 (100)  | 0             | 27 (1)        |
| Keratoconjunctivitis                                  | 23 (92)   | 2 (8)         | 25 (1)        |
| HIV/AIDS                                              | 5 (33)    | 10 (67)       | 15 (<1)       |
| Other                                                 | 125 (52)  | 114 (48)      | 239 (8)       |
| Total                                                 | 937 (31%) | 2,071 (69%)   | 3,008         |

Figure 1 Number of claims of blood contact (BC) and cost for the compensation board from 2005 to 2009; data from BGW, Germany.
TB. However, for LTBI recognised as an OID, the absolute number increased from five in 2006 to 65 in 2009. In 2005 the data set did not yet allow for a distinction to be made between LTBI and active TB.

ABC (55%) and NSIs (70%) are most often reported at hospitals (Table 2). In 2009, the rate per 1,000 employees in hospitals was 29.9 for NSIs and 2.8 for ABC. The second highest NSI rate per 1,000 employees was seen in surgeries (12.0). Claims of NSI increased by 2.1% from 2008 to 2009, with the largest rise seen in outpatient care (7.3%). Claims of ABC increased by 6.7% from 2008 to 2009, with the largest rise seen in nursing homes (20.9%). The rate for all recognised OIDs was highest in hospitals and second highest in nursing homes (15.3 versus 8.3/100,000, Table 4). In hospital workers the annual mean rate of recognised OIDs was highest for TB (5.7/100,000) followed by HCV (4.8/100,000).

### Discussion

To our knowledge this study is the first attempt to describe in detail the number of infectious diseases in German HCWs using data of a compensation board. This analysis has revealed different time trends. The most significant trend is that the number of HBV and HCV infections recognised as OIDs has declined during the last 15 years, with HCV infection now more often being the cause of an OID than HBV infections. However, the cases of NSIs and ABCs (splashes) filled to the board increased steadily over the last five years.

So far, only a few analyses of compensation claims by HCWs have been published. A US analysis of NSI claims by HCWs eligible to file a state fund workers’ compensation claim in Washington State established that the incidence of NSI claims per 1,000 HCWs employed in hospitals was 15.9, in dental offices 10.5, in physicians’ offices 8.7 and in

---

**Figure 2** Number of claims of needlestick injuries (NSIs) and cost for the compensation board from 2005 to 2009; data from BGW, Germany.

**Figure 3** Number of suspected and recognised cases of HBV and HCV infections from 2005 to 2009, data from BGW, Germany.
skilled nursing facilities 8.1 [17]. In our data set, rates of NSIs per 1,000 employees were twice as high in hospitals (29.8) but half as high in nursing homes (3.7). However, not all facilities clustered in this working area can be classified as skilled nursing facilities and therefore our denominator in this group is inflated. In addition, comparison of the two studies is not possible as different time periods were analysed (1996 to 2000 in the US study [17] and 2008 to 2009 in our study).

A second study based on compensation claims for OIDs was a case series of HCWs with confirmed MRSA infections [18]. The authors used the same data set as we did to identify MRSA-related OID claims and performed an in-depth analysis of the individual files. In total 17 MRSA-related OIDs were identified in HCWs. The analysis of compensation claims by veterinarians in Germany found an increased risk of animal-related accidents and infections [19]. The literature that has been published to date on claims filed by HCWs makes it clear that, whatever the shortcomings of this data, analysing compensation claims by HCWs can be helpful in tackling the occupational risks faced by HCWs.

In Germany, a low-incidence country for TB, the rate of active TB as an OID in HCWs was even lower than expected (5.5/100,000 in the general population and 1.5/100,000 in HCWs). Under-representation of HCWs among patients with active TB was also observed in the Hamburg fingerprint study [5]. However, it should be noted that HCWs do not share most other risks for active TB, for example homelessness, intravenous drug

### Table 2 Number of needlestick injuries and blood contact cases and annual mean rates per 1,000 employees by different risk groups in 2008 and 2009; data from BGW, Germany

| Risk group      | Needlestick injuries | Blood contact |
|-----------------|----------------------|---------------|
|                 | 2008 N (col%)        | 2008 N (col%) | 2009 N (col%) | 2009 N (col%) | Difference (%) | Annual rate+ | 2008 N (col%) | 2009 N (col%) | 2008 N (col%) | 2009 N (col%) | Difference (%) | Annual rate+ |
| Hospitals       | 21,896 (56)          | 22,100 (55)   | +0.9         | 29.9         | 1,996 (70)     | 2,089 (70)    | +4.7         | 2.8          |
| Surgeries       | 8,379 (21)           | 8,442 (21)    | +0.8         | 12.0         | 413 (15)       | 464 (16)      | +12.3        | 0.6          |
| Nursing homes   | 3,828 (10)           | 4,073 (10)    | +6.4         | 3.6          | 139 (5)        | 168 (6)       | +20.9        | 0.1          |
| Outpatient care | 1,589 (4)            | 1,706 (4)     | +7.3         | 4.2          | 46 (2)         | 41 (1)        | -10.9        | 0.1          |
| Others          | 3,403 (9)            | 3,598 (9)     | +5.7         | 1.5          | 253 (9)        | 229 (8)       | -9.4         | 0.1          |
| **Total**       | **39,095**           | **39,919**    | **+2.1**     | **7.4**      | **2,847**      | **2,991**     | **+6.7**     | **0.6**      |

* Difference calculated as change from 2008 to 2009; negative change means reduction; positive change means increase.
*+ Calculated per 1,000 employees averaged over two years (2008 and 2009).

### Table 3 Number of suspected (S) and recognised (R) cases of selected occupational infectious diseases by year of notification and annual rates of recognised cases per 100,000 employees; 2005–2009; data from BGW, Germany

| Occupational infectious diseases | 2005 N | 2006 N | 2007 N | 2008 N | 2009 N | Total N (col%) | Year | Annual rate of recognised cases+ |
|---------------------------------|--------|--------|--------|--------|--------|---------------|------|---------------------------------|
| Active TB                       | 254    | 175    | 253    | 195    | 124    | 990           |      |                                 |
| LTBI                            | 99     | 83     | 6      | 73     | 61     | 372 (38)      | 1.5  |                                 |
| Scabies                         | -      | 20     | 33     | 40     | 187    | 280           |      |                                 |
| MRSA                            | -      | 114    | 88     | 98     | 102    | 402           |      |                                 |
| HBV                             | 146    | 116    | 110    | 106    | 75     | 553           |      |                                 |
| HCV                             | 40     | 29     | 30     | 20     | 14     | 133 (24)      | 0.5  |                                 |
| HIV/AIDS                        | 9      | 12     | 4      | 11     | 5      | 41            |      |                                 |

* Proportion of the suspected cases that were recognised as occupational infectious diseases between 2005 and 2009.
*+ Calculated per 100,000 employees averaged over five years (2005–2009).

LTBI = latent TB infection.
the interferon-

diagnosing LTBI, which was brought about by introducing

than in the years before. This reflects the improvement in

and recognised as an OID more often in 2008 and 2009

contacts of the general population [11]. LTBI was reported

to active TB seems to be lower in HCWs than in close

abuse or alcoholism. Therefore the risk of progression

to active TB seems to be lower in HCWs than in close

contacts of the general population [11]. LTBI was reported

and recognised as an OID more often in 2008 and 2009

in the years before. This reflects the improvement in
diagnosing LTBI, which was brought about by introducing
the interferon-γ release assay into routine screening of
HCWs [20-24]. High progression rates in close contacts to
TB patients observed in Germany further fostered the
awareness of LTBI as a risk for HCWs [25,26].

HBV infection can be prevented by vaccination. In
Germany, vaccinations are offered to every HCW at risk
of infection during a mandatory physical examination at
the workplace following the Biological Agents Ordinance.
Therefore, HBV vaccination coverage in German HCWs is
high and the decreasing number of HBV-related OIDs is
well explained. However, the number of HCV-related
OIDs decreased as well. A similar trend was observed in
France [2]. As no vaccine is available for HCV, this might
indicate improvements in the realm of occupational
hygiene.

Experiences in the US and France demonstrate that NSIs
can be prevented [13,27]. In Germany the number of NSIs
reported is still high, and it should be assumed that the
real incidence of NSIs in HCWs is even higher due to
under-reporting. In 2008 regulations on the use of safety
devices became more rigorous in Germany. Following
these regulatory changes, safety devices were more often
used in German healthcare. In the absence of a systematic
evaluation, the experience in Hamburg might be reported.
After informing hospitals about the new regulations and
advising these hospitals on safety devices, all hospitals in
Hamburg introduced them to varying degrees and subse-
sequently reported a decrease in NSIs [28]. However, the
number of NSI related claims to the compensation board
so far did not decrease. Annual costs for ABC and NSIs
amounted to about 4 million euros. However, it should be
noted that the real cost is underestimated because the
compensation cost for blood-borne infections is not
included in this estimate and under-reporting of ABC and
NSIs is very likely. A more in-depth analysis of the cost of
OIDs might be helpful in order to demonstrate the eco-
nomic burden of OIDs in healthcare.

Limitations
This analysis was based on the routine data of one com-
 pensation board, which covers about two thirds of all
HCWs in Germany. The completeness of the data depends
on the willingness of physicians and HCWs to report inci-
dents. It might be safe to assume that – especially with less
severe infectious diseases – there is considerable under-
reporting because little monetary interest is involved. The
annual incidence of NSI in HCWs of a university hospital
was 31.4% [29]. Compared to the annual rate of 29.9 NSI
per 1,000 employees in hospitals (Table 2), it follows that
about 10% of the NSI are reported to the compensation
board. The advisors who are responsible for documenting
clamns are trained for their task. However, the quality of
data entries is controlled in a rather superficial way.
Therefore misclassification is likely. These limitations
considered, the standard data set on occupational dis-
 eases of the Berufsgenossenschaft (compensation board)
allow for a cautious estimate of the risk of infectious dis-
eses in HCWs in Germany and enable meaningful time
trends to be observed.

As the risk for OID remains high (e.g. 15.3/100,000
hospital employees, Table 4), awareness for the infection
risk and knowledge about infection prevention should be
improved [30,31]. Communicating the safety and effect-
iveness of vaccination will be an important issue in this
endeavour [32-34] as well as improvements in protective
equipment likes gloves or safety devices [35,36].

Conclusion
Even though Germany is a low-incidence country, TB still
poses a threat for HCWs and screening for TB should
therefore be maintained. Even though they are declining,
HBV and HBV infections are still frequent and trends
should be watched closely. Trends in NSIs should be
observed closely in the following years in order to evaluate
the effect of new regulations on the use of safety devices.

Competing interest
The authors work for the compensation board for which the data were
analysed. However, the compensation board did not try to influence the
content of this article in any way. Therefore, the authors declare that they do
not have any direct or indirect personal relationship, affiliation or association
with any party with whom they deal in their day-to-day work that would
give rise to any actual or perceived conflict of interest.

Authors’ contributions
AN wrote the paper. CK made substantial contributions to the revision of
the first draft. DW analysed the data. FH made substantial contributions to

| Occupational infectious disease | Hospitals | Surgeries | Nursing homes | Outpatient care | Others |
|--------------------------------|-----------|-----------|---------------|----------------|--------|
| Active TB                      | 5.7       | 2.1       | 0.8           | 0.8            | 0.4    | 1.5    |
| LTBI                           | 1.1       | 0.7       | 0.2           | 0.2            | 0.1    | 0.4    |
| Scabies                        | 1.3       | 0.1       | 6.0           | 0.6            | 0.1    | 1.5    |
| MRSA                           | 0.3       | 0.0       | 0.3           | 0.2            | 0.0    | 0.1    |
| HBV                            | 1.9       | 0.7       | 0.2           | 0.3            | 0.2    | 0.5    |
| HCV                            | 4.8       | 3.0       | 0.8           | 1.4            | 0.5    | 1.5    |
| HIV/AIDS                       | 0.1       | 0.0       | 0.0           | 0.0            | 0.0    | 0.02   |
| **Total**                      | **15.3**  | **6.6**   | **8.3**       | **3.5**        | **1.3** | **4.5** |

LTBI = latent TB infection.
the revision of the first draft. MD analysed the data and made substantial contributions to the revision of the first draft. All authors read and approved the final manuscript.

Received: 20 March 2012 Accepted: 3 May 2012

Published: 3 May 2012

References
1. Sepkowitz KA, Eisenberg L: Occupational deaths among healthcare workers. Emerg Infect Dis 2005, 11(7):1003–1008.
2. Tarantola A, Abetbolud D, Rachline A: Infection risks following accidental exposure to blood or body fluids in health care workers: A review of pathogens transmitted in published cases. Amer J Ind Contri 2006, 34(6):367–375.
3. Baussano I, Nunn P, Williams B, Pivetta E, Bugiani M, Scano F: Tuberculosis among health care workers. Emerg Infect Dis 2011, 17(3):488–494.
4. Seidler A, Nienhaus A, Diel R: Review of epidemiological studies on the occupational risk of tuberculosis in low-incidence areas. Respiration 2005, 72(4):431–446.
5. Diel R, Seidler A, Nienhaus A, Rusch-Gerdes S, Niemann S: Occupational risk of tuberculosis transmission in a low incidence area. Respir Res 2005, 6(1):35–45.
6. Ho PL, Becker M, Chan-Yeung MM: Occupational deaths among healthcare workers. J Infect Dis 2005, 191(12):711–721.
7. Poon LL, Guan Y, Nicholls JM, Yuen KY, Peiris JS: Predictive value of a whole blood IFN-c assay for the development of active TB disease. Am J Respir Crit Care Med 2008, 177:1164–1170.
8. Diel R, Loddenkemper R, Meywald-Walter K, Niemann S, Nienhaus A: Negative and positive predictive value of a whole-blood Interferon-γ Release Assay for developing active tuberculosis - An Update. Am J Respir Crit Care Med 2011, 183:886–95.
9. Isaacson RE, Tomlinson SG, Wight R, Desai J, Grainger AJ: Needlestick injury rates according to different types of safety-engineered devices: results of a French multicenter study. Infect Control Hosp Epidemiol 2010, 31(4):402–407.
10. Leung CB, To KF, Lui SF, Szeto CC, Chung S, Sung JJ: Major outbreak of severe acute respiratory syndrome. Lancet Infect Dis 2004, 4(11):663–671.
11. Lee N, Hui D, Wu A, Chan P, Cameron P, Joynt GMA, Ahuja A, Yung MY, Leung CB, To KF, Lui SF, Szeto CC, Chung S, Sung JJ: Major outbreak of severe acute respiratory syndrome in Hong Kong. N Engl J Med 2003, 348(20):1986–1994.
12. Booth CM, Matukas LM, Tomlinson GA, Rachlis AR, Rose DB, Dowsw AH, Walmsley SL, Mazzulli T, Avendano D, Derkach P, Ephthimiou I, Kita J, Mederski BD, Shadowitz SB, Gold WL, Hawryluck LA, Rea E, Chenkin JS, Cescon DW, Poutanen SM, Detsky AS: Clinical features and short term outcomes of 144 patients with SARS in the Greater Toronto Area. JAMA 2003, 289(21):2801–2809.
13. Buiston Bridges C, Katz JM, Seto WH, Chan PK, Tsang D, Ho W, Mak KH, Lim W, Tam JS, Clarke M, Williams SG, Mounts AW, Bresé J, Conn LA, Rowe T, Hu-Primmer J, Anemathy RA, Lu X, Cox NJ, Fukuda K: Risk of influenza A (H5N1) infection among health care workers exposed to patients with influenza A (H5N1), Hong Kong. J Infect Dis 2000, 181:344–348.
14. Costa JT, Silva R, Tavares M, Nienhaus A: High effectiveness of pandemic influenza A (H1N1) vaccination in healthcare workers from a Portuguese hospital. Int Arch Occup Environ Health 2011, PMID: 22045387. epub ahead of print.
15. Sepkowitz KA: Tuberculosis and the healthcare worker. A historical perspective. Ann Intern Med 1994, 120(12):71–79.
16. Phillips EK, Conaway MR, Jagger JC: Percutaneous injuries before and after the Needlestick Safety and Prevention Act. N Engl J Med 1994, 336(17):670–671.
17. TRBA 250 - Technische norm biologische working material 250 (Technische Regelle Biologische Arbeitsstoffe) last revision. : 2008. http://www.baka.de/trba_15116/de/Themenvon-A-Z/BiologischeArbeitstoffe/TRBA/pdf/TRBA-250.pdf (in German).
18. European Commission: Commission Recommendation of 19th September 2003 concerning the European schedule of occupational diseases: 2003/670/EC. http://eur-lex.europa.eu/JOHMdo?uri=OJ:L:2003:304:HTML
19. von Hirschberg KR, Kähler B, Nienhaus A: Social care and changes in occupational accidents and diseases – the situation in Eastern Europe in general and for skin diseases in particular. J Occup Med Toxicol 2009, 4:28.
20. Shah SM, Bonauto D, Silvestre B, Foley M: Workers’ compensation claims for needlestick injuries among healthcare workers in Washington State, 1996–2000. Infect Control Hosp Epidemio 2005, 26(9):775–781.
21. Haamann F, Dulan M, Nienhaus A: MRSA as an occupational disease: a case series. Int Arch Occup Environ Health 2011, 84(3):259–266.
22. Nienhaus A, Skuldt C, Seidler A: Work-related accidents and occupational diseases in veterinarians and their staff. Int Arch Occup Environ Health 2005, 78:239–238.
23. Nienhaus A, Schablon A, Sano B, le Bacle C, Diel R: Evaluation of the interferon-gamma release assay in healthcare workers. Int Arch Occup Environ Health 2008, 81:295–300.
24. Torres Costa J, Sá R, Cardoso MJ, Silva R, Ferreira J, Ribeiro C, Miranda M, Plácido JL, Nienhaus A: Tuberculosis screening in Portuguese healthcare workers using the tuberculin skin test and the interferon-gamma release assay. Eur Respir J 2009, 34:1423–1428.
25. Diel R, Loddenkemper R, Meywald-Walter K, Niemann S, Nienhaus A: Predictive value of a whole blood IFN-c assay for the development of active TB disease. Am J Respir Crit Care Med 2008, 177:1164–1170.
26. Diel R, Loddenkemper R, Niemann S: Meywald-Walter, Nienhaus A: Negative and positive predictive value of a whole-blood Interferon-γ Release Assay for developing active tuberculosis - An Update. Am J Respir Crit Care Med 2011, 183:886–95.
27. Wicker S, Jung J, Allwinn R, Gottschalk R, Rabenau HF: Prevalence and prevention of needlestick injuries among health care workers in a German university hospital. Int Arch Occup Environ Health, 2008, 81(3):347–354.
28. Deuffic-Burban S, Dalarocque-Astagneau E, Abitelboul D, Bouvet E, Yanzapanah Y: Blood-borne viruses in a health care workers: prevention and management. J Clin Virol 2011, 52(1):4–10.
29. Hoffmann F, Ferracin C, Marsh G, Dumas R: Influenza vaccination of healthcare workers: a literature review of attitudes and beliefs. Infection 2006, 34(3):142–147.
30. Johnson JS, Talbot TR: New approaches for influenza vaccination of healthcare workers. Curr Opin Infect Dis 2011, 24(4):363–369.
31. McLennan S, Wicker S: Reflections on the influenza vaccination of healthcare workers. Vaccine 2012, 29(5):8061–8064.
32. Wicker S, Rabenau HF, Doerr HW, Allwinn R: Influenza vaccination compliance among health care workers in a German university hospital. Infectious Diseases in Health Care Workers. Infect Control Hosp Epidemio 2010, 31(5):498–502.
33. Wicker S, Kralj N, Kover J, Gasthuis K, Lerch H, Hoffmann F: Comparison of 4 different types of surgical gloves used for preventing blood contact. Infect Control Hosp Epidemio 2010, 31(5):498–502.
34. Wicker S, Kralj N, Kover J, Gasthuis K, Hoffman F: Study of blood contact in simulated surgical needlestick injuries with single or double latex gloves. Infect Control Hosp Epidemio 2009, 30(1):53–56.