Tuberculosis Risk in Funeral Home Employees

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In order to estimate the risk of tuberculosis infection among employees in the funeral service industry, we conducted a risk-assessment study of a convenience sample of funeral home employees. Study participants completed a risk-assessment questionnaire and underwent tuberculin skin testing. Of 864 employees tested, 101 (11.7%) had a reactive tuberculin skin test. Reactivity to the tuberculin skin test was significantly associated with job category; funeral home employees with a present or past history of embalming deceased-human remains were twice as likely to be reactive as were non-embalming personnel (14.9% versus 7.2%, $P < 0.01$). Reactivity was also associated with age, gender, race, past history of close contact with a person diagnosed with tuberculosis, and work history. After controlling for age and other factors, tuberculin reactivity was found to be associated in embalming personnel with the number of years spent performing embalmings (≥ 20), and, in non-embalming personnel, with a history of close contact with infected individuals. Based on these results, it is recommended that funeral home employees who routinely embalm cadavers undergo annual tuberculin skin testing, receive initial training on tuberculosis prevention, and wear respiratory protection when preparing known tuberculosis cases.

Occupational transmission of tuberculosis among health care workers, including pathology and forensic workers, has been well documented. Tuberculin skin test conversions and reports of disease were frequent among health care workers prior to the availability of effective antimicrobials.[1] When tuberculosis reemerged as a public health problem in the late 1980s, a corresponding increase in exposure and disease was also noted among health care workers.[2–9] Over the past few years, several tuberculosis outbreaks in health care workers have been documented, including one that involved an outbreak of a multiple drug–resistant strain of *Mycobacteria tuberculosis* among employees in a medical examiner's office.[10] The risk factors associated with *M. tuberculosis* transmission among forensic workers have been identified; they include performing autopsies, especially on patients who were infected with the human immunodeficiency virus (since they may be more likely to have disseminated tuberculosis), and the dissection of cadavers with undiagnosed tuberculosis disease.[11–18] However, for funeral industry workers, the frequency of tuberculosis infection and the associated risk factors have not been well defined. Since routine mortuary procedures are presumably less invasive than those involved in performing an autopsy, the risk of tuberculosis in funeral home employees who embalm is likely to be lower. However, our results from a small pilot study involving 123 Maryland licensed embalmers indicated that the risk of tuberculosis exposure in this population might be higher than anticipated.[19] We found that funeral directors

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who routinely embalmed had a tuberculin reaction rate of 19.5%, and the rate of skin-test reactivity was positively associated with the number of weekly embalmings performed. In addition, recent reports from the Centers for Disease Control and Prevention on occupational risk for tuberculosis mortality noted that white male funeral directors had the third highest proportionate mortality ratio for tuberculosis, and a recent article by McKenna and colleagues found elevated standardized morbidity ratios for funeral directors.[20,21] Since the population of funeral industry workers in the United States is large, with approximately 45,000 licensed funeral service practitioners routinely embalming deceased humans and an additional 89,000 funeral industry employees providing ancillary services (eg, arrangers, cosmeticians, dressers, drivers, preparation-room attendants, receptionists, removers, secretaries, and transporters), it is important to better understand the occupational risk of tuberculosis in this profession in order to make appropriate risk-reduction recommendations.

How might we explain the occupational risk of tuberculosis among funeral home workers, including embalmers who generally do not open the chest cavity of the deceased? Hypothetically, the practice of embalming, which is common in this country, may result in the generation of infectious aerosols. Routine embalming procedures include the aspiration of blood and other body fluids from the deceased's hollow organs and the infusion of preservatives and disinfectants (under as much as 3–5 lbs of pressure) into the arteries (James F. Burnside III, Certified Funeral Service Practitioner [CFSP], personal communication, 1996). Using gravity feed, hollow organs such as the heart, lungs, and kidneys are routinely perfused. These procedures may result in the generation of infectious droplets.

The aspirated body fluids and perfused liquids are routinely emptied into floor, table, or sink drains, again possibly resulting in aerosol generation. In addition, fluid build-up in the deceased's chest cavity from putrefaction of tissues and organs may result in frothing and gurgling at the deceased's nose and mouth. Residual air in the deceased's lungs may be released when the body is moved and shifted about. In addition, cadaveric spasms, which occur when groups of muscles contract, may lead to lung purge and the release of trapped air bubbles through the nose and mouth. Once infectious aerosols are generated, tubercle bacilli may remain viable for extended periods of time.[22–24] The issue of infectious aerosols, including the generation of airborne tubercle bacilli, has never been studied in this context, and thus we simply do not know how feasible it is to transmit tuberculosis within this setting. In the absence of information, embalmers have for years traditionally relied upon the practice of tightly packing cotton wadding (pretreated with an Environmental Protection Agency [EPA])–approved germicidal disinfectant) into the deceased's orifices to help reduce the risk of potential aerosol exposure (James F. Burnside III, CFSP, personal communication, 1996). More recently, embalmers have begun the practice of placing a filter mask over the mouth of the deceased during all preparatory work.

In addition to the potential risk of tuberculosis exposure from the deceased-human remains, another potential source of infectious droplets in the funeral home might be from infected visitors and family members visiting the funeral home. Many funeral home directors, in addition to performing embalmings, also work in very close contact with family members as they plan and conduct the funeral—this work is referred to as "arranging." Frequently, funeral directors who retire from embalming start spending more time on arranging. This aspect of their work can potentially bring them into contact with large numbers of the general public. For instance, each funeral, on average, generates between 50 and 100 visitors (David J. Weber, CFSP, personal communication), and infectious droplet nuclei may be generated when diseased visitors speak, weep, or cough. Finally, another potential source of exposure for funeral home employees might be their coworkers with active tuberculosis.

It should be noted that funeral homes, including embalming preparation rooms, are not required to adhere to the stringent air quality requirements of hospitals, and in particular, of hospital autopsy suites.[25] Specific work practice guidelines to limit exposure to tuberculosis have not yet been implemented for funeral home workers; current Centers for Disease Control and Prevention (CDC) tuberculosis guidelines and the Occupational Safety and Health Administration (OSHA) tuberculosis compliance directives have generally not been applied to the funeral home setting.[26–28]

In order to estimate the risk of tuberculosis infection in funeral home employees and to identify risk factors associated with tuberculin test reactivity, including the mode of transmission, a prevalence study was conducted among persons who attended an annual convention of the National Funeral Directors Association.

Methods

Subjects

The National Funeral Directors Association, with over 14,000 members, is the single largest professional organization for funeral home employees in the United States. At a recent funeral directors convention, with approximately 2400 licensed embalmers in attendance, an information booth concerning the study was set up adjacent to the registration area. Registrants were asked to voluntarily participate in the study, which was well advertised and endorsed by the organization's leadership. Eligibility was limited to indi-

viduals over 18 years of age who currently or formerly worked (paid or unpaid) at least part-time in a funeral home. Although approximately 1200 attendees visited our booth, many were spouses or sales representatives and thus ineligible to participate. A total of 897 eligible funeral home employees agreed to participate in the study; participation included completing a six-page risk-assessment questionnaire and undergoing tuberculin skin testing. However, only 864 volunteers actually underwent skin testing; 23 individuals were ineligible for testing due to a past history of either tuberculosis (disease) or a history of a tuberculin reaction in excess of 25 mm, and 10 others were excluded for other reasons (eg, skin disorders, pregnancy, etc). Our analyses only include the results of the 864 funeral home employees who were actually tested. All procedures for participants were reviewed and approved by the Johns Hopkins University School of Public Health Committee on Human Volunteers.

Tuberculin Skin-Testing Procedures

A team of five registered nurses administered the tuberculin skin tests during the week-long convention and determined the results 48–72 hours later. The team underwent standardized training by an experienced clinical nurse coordinator, who also provided direct supervision and was responsible for quality control measures. Testing was performed using the Mantoux method, containing 0.1 mL of purified protein derivative of tuberculin containing 5 tuberculin units (Tubersol purified protein derivative; Pasteur Merieux Connaught, Swiftwater, PA). All indurations were measured with a caliper ruler, and the transverse diameter of palpable induration was recorded. Based on published criteria for health care workers, an induration of $\geq$10 mm was considered positive.[29] Persons were not excluded because of a past history of vaccination with Bacille bilié de Calmette-Guérin (BCG). All study participants were counseled by one of the nurses regarding the test procedures, and informational brochures were distributed as well. Participants who knew beforehand that they would be leaving the convention early and thus could not be evaluated on-site were provided with a pre-addressed, prepaid, postcard that gave detailed instructions on reading and recording the response. The completed postcards were mailed back to our study office. All study participants were also provided with a detailed disclosure statement that urged those with a positive result to contact their family physician.

Questionnaire

A six-page questionnaire was constructed to identify risk factors known to be associated with either community or occupational transmission of tuberculosis. The questionnaire included items on both community and individual risk factors (age, gender, race, education, country of birth, family history of tuberculosis, health status, etc) and occupational risk factors (embalming and autopsy history, including history of embalming or conducting autopsies on deceased human remains known to be infectious for tuberculosis; type of ventilation in preparation rooms; types and frequency of mask or respirator use; history of packing the nose and mouth of the deceased with cotton soaked in EPA-approved germicidal disinfectant; training in tuberculosis risk-management techniques; knowledge of tuberculosis transmission and risk factors; exposure to a living person with active tuberculosis [eg, coworker or client]; location of funeral home; and health status of funeral home clientele). (Copies of the questionnaire and coding information are available upon request.)

Chi-square analyses were used to test the statistical significance of associations with positive tuberculin reactions (outcome measure). Crude and adjusted prevalence ratios were calculated, and multivariate regression procedures were used to determine the model of best fit when potential confounders, such as age and gender and other variables, were controlled.

Results

Demographic Results

Participants were predominantly male (67.7%), white (94.0%), and had a mean age of 49.7 years. Most had at least a high school education. Over 95% of the participants were born in the United States and few ($n = 18$) had lived in another country for more than six months. Participants came from each region of the United States, with most of the participants working in the northeast (20.1%) or south Atlantic (22.9%) regions, generally in non-urban areas. The demographic results of the study participants closely mirrors the demographic profile of the entire association membership (personal communication, National Funeral Directors Association).

There were 504 participants who reported that they were licensed embalmers (either currently practicing or retired). Of these, 471 (93.4%) also reported that they frequently arranged funerals. There were 360 non-embalming funeral home employees, including arrangers, secretaries, administrative personnel, and drivers. The demographic profile results of the two categories of study participants are summarized and compared in Table 1.

Licensed Embalmers

Embalmers were noted to differ from non-embalmers on a number of demographic variables (age, gender, education levels and country of origin). Embalmers tended to be white, middle-aged males, with many years of experience in preparation rooms; 63% reported working 21 years or more in preparation rooms. The average number of weekly embalmings

TABLE 1
Demographic Comparisons Between Embalming and Non-Embalming Funeral Home Employees (n = 864)

Characteristics	Embalmer (n = 504)	Non-Embalmer (n = 360)	P Value
Age			
<50 years	225 (44.6%)	203 (56.4%)	<0.001
≥50 years	279 (55.4%)	157 (43.4%)	
Gender			
Male	453 (52.4%)	132 (36.7%)	<0.001
Female	50 (9.9%)	227 (63.1%)	
Missing	1	1	
Race			
White	475 (94.3%)	337 (93.6%)	0.852
Non-white	28 (5.6%)	21 (5.8%)	
Missing	1	2	
Educational level			
<13 years	22 (4.4%)	57 (15.8%)	<0.001
≥13 years	482 (95.6%)	303 (84.2%)	
Country of origin			
United States	492 (97.6%)	333 (92.5%)	0.027
Other	6 (1.2%)	12 (3.3%)	
Missing	6	15	
Location of firm			
Rural	175 (34.7%)	129 (35.8%)	0.138
Suburban	164 (32.5%)	93 (25.5%)	
City	160 (31.7%)	127 (35.3%)	
Missing	5	11	

performed was 3.1 (range = 0–200). Licensed embalmers reported large numbers of lifetime embalmings: 82.5% had performed more than 500, and 67.1% reported more than 1000 lifetime embalmings. The average number of yearly embalmings per facility was 170. Nearly 18% of licensed embalmers reported that they had previously embalmed human remains infectious for *M. tuberculosis* (eg, active tuberculosis), with an average of 26 such embalmings. While nearly all of the embalmers (98%) stated that they were fully aware if a decedent had a history of active tuberculosis, only half took any special precautions in addition to universal precautions (to protect against exposure to bloodborne pathogens). Information on the deceased's tuberculosis status generally came from either the hospital staff or from the death certificate.

Tuberculin Skin Testing

Over 96% (n = 834) of all participants returned on the second or third day after testing to have the results evaluated by one of the nurses. Individuals who did not return or who did not mail back their postcard were contacted by telephone by the study coordinator. All participants with a result in excess of 25 mm were followed-up by telephone by the clinical nurse coordinator within two weeks of the testing to ensure that the proper follow-up medical care had been obtained; in all of these cases, contact with a physician had been made and, in most cases, chemoprophylaxis was prescribed.

Skin test results. A total of 101 (11.7%) of all funeral home employees were tuberculin reactors. The rate of reactivity in licensed embalmers was 14.9% (n = 75), the rate in embalmers who also arranged funerals was 13.3% (n = 67), and the rate of reactivity in non-embalming personnel was 7.2% (n = 26). The prevalence rate for embalmers was significantly higher than the rate for non-embalming personnel (odds ratio [OR] = 2.2, 95% confidence interval [CI_{95}] = 1.4, 3.6), even after simultaneous adjustment for age and gender (OR = 1.92, CI_{95} = 1.09, 3.4). If we include the 23 individuals (all of them were embalmers with arranging duties) who were excluded because of their past history of tuberculosis, then the rate for embalmers was 18.6%. There were no non-embalming personnel excluded because none of them gave a past history of tuberculosis.

Sixty-nine percent (n = 596) of all study participants reported a lifetime history of a prior tuberculin test, generally by needle and syringe or multiple puncture test; of these, 44 (7.4%) reported that they had previously tested positive. Upon retesting, 33 (75%) of these individuals were found to be tuberculin reactors. Only 12.0% (n = 104) of the participants reported having been tuberculin skin tested in the past three years, and only 45 (5.2%) had been tested in the previous 12 months. Fifty-four individuals reported that they had received BCG in the past, and of these, 7 (13%) were found to be reactive upon testing, and all were embalmers.

Community and Demographic Factors

Associations with tuberculin reactivity in funeral home employees (n = 864). On bivariate analysis, tuberculin reactivity was significantly associated with age (≥50 years), gender (male), race (non-white), job category (embalmer) and history of close contact with an individual known to have tuberculosis (disease) (eg, family member) (Table 2). Tuberculin reactivity rate was not found to be associated with level of education, rural versus urban location of firm, place of birth, country of origin, history of living in another country, or health status (smoking, lung disorders, alcoholism, etc) including compromised immunity.

Associations with tuberculin reactivity in non-embalming funeral home employees (n = 360). In Table 3, the factors significantly associated with reactivity in non-embalming personnel are shown. These include

TABLE 2
Significant Associations with Tuberculin Reactivity in Funeral Home Employees (n = 864)*

Variable	n	Reactives n (%)	Odds Ratio (CI_{95})
Age			
<50 years	428	34 (7.9)	1.0
≥50 years	436	67 (15.4)	1.8 (1.2, 2.8)
Gender			
Female	277	23 (8.3)	1.0
Male	585	78 (13.3)	1.7 (1.1, 2.8)
Missing	2		
Race			
White	812	91 (11.2)	1.0
Non-white	49	10 (20.4)	2.9 (1.4, 6.4)
Missing	3		
Job category			
Non-embalmer	360	26 (7.2)	1.0
Embalmer	504	75 (14.9)	2.2 (1.4, 3.6)
Close contact with known (live) TB case			
No	635	71 (11.2)	1.0
Yes	92	19 (20.7)	2.1 (1.2, 3.6)
Missing	137		

* CI_{95}, 95% confidence interval; TB, tuberculosis.

TABLE 3
Tuberculin Reactivity in Non-Embalming Funeral Home Employees (n = 360)

Characteristic	n	Reactives n (%)	Odds Ratio (CI_{95})
Age			
<50 years	203	10 (4.9)	1.0
≥50 years	157	16 (10.2)	2.2 (1.0, 4.9)
Gender			
Female	277	13 (5.7)	1.0
Male	132	13 (9.8)	1.8 (0.8, 3.9)
Missing	1		
Race			
White	337	22 (6.5)	1.0
Non-white	21	4 (19.0)	4.6 (1.3, 16.3)
Missing	2		
Close contact with known (live) TB case			
No	253	15 (5.9)	1.0
Yes	38	8 (21.1)	4.2 (1.7, 10.6)
Missing (don't know)	69		

age (≥50 years), gender (male), race (non-white), and history of close contact. These data are consistent with known tuberculosis risk factors for the general population.[30]

Associations with tuberculin reactivity in licensed embalmers (n = 504). In the bivariate analyses, the tuberculin reactivity rate in embalmers was significantly associated with age (≥50 years), number of years embalming (tenure) (≥20 years), and number of lifetime embalmings (≥1000) (Table 4). After applying logistic regression techniques to the model, only years of embalming remained statistically significant (OR = 6.9, CI_{95} = 2.9, 16.4).

Reactivity was not associated with a history of performing embalmings on known tuberculosis-infected deceased human remains or with a history of assisting at autopsies. Reactivity was also not correlated with environmental, work practice, or administrative controls as detailed below.

Environmental Control Factors and Reactivity in Embalmers

Various ventilation controls currently used in preparation rooms were reported by licensed embalmers, including frequent air changes (54.0%), window fans (35.4%), negative air pressure in preparatory rooms (29.6%), and non-recirculated air (14.2%). Over 65% (n = 334) of embalmers reported that improvements had been made in their ventilation systems within the previous twelve months. Reactivity was not associated with type of ventilatory control currently in place.

Work Practice Control Factors and Reactivity in Embalmers

Embalmers reported on their personal respiratory protection practices. Sixteen percent (n = 81) reported always wearing a face mask during embalmings, while 56.2% (n = 283) infrequently or rarely wore a face mask during such procedures. Most practitioners wore a standard surgical mask (32.9%), followed by plain paper masks (26.2%), and fluid-resistant surgical masks (17.8%). Only 9% (n = 45) wore any type of respirator, including full- or half-face high-efficiency particulate air filter respirators. Reactivity was not associated with type of face mask worn, frequency of use, or history of past use.

The practice of packing the deceased's mouth or nose with cotton wadding soaked in EPA-approved germicidal disinfectant to contain fluids and droplets was reportedly always practiced by 26.8% (n = 135) of embalmers, while 53.0% (n = 267) reported that they infrequently or rarely packed the orifices. A history of mouth packing was not significantly associated with tuberculin skin test reactivity.

Administrative Factors

Fifty-four percent (n = 272) of embalmers reported receiving any tuber-

TABLE 4
Significant Associations with Tuberculin Reactivity in Embalmers (n = 504)

Characteristics	n	Reactives n (%)	Odds Ratio (CI_{95})
Age (years)			
<50	225	24 (10.7)	1.0
≥50	279	51 (18.3)	1.9 (1.1, 3.1)
Job tenure (number of years embalming)			
<20	192	12 (6.3)	1.0
≥20	312	63 (20.2)	3.8 (2.1, 7.2)
Lifetime number of embalmings			
<1000	164	16 (9.8)	1.0
≥1000	340	59 (17.4)	1.9 (1.1, 3.5)

culosis training during their career, but only 16.7% (n = 84) reported receiving some tuberculosis training in the past 12 months. Nevertheless, embalmers had high scores on a test of knowledge of the routes of transmission of tuberculosis (average score = 4.3 out of a possible 5 points). Tuberculin skin-test reactivity was not associated with a history of past training on tuberculosis or with test scores.

Discussion

The results of this study suggest that licensed embalmers may be at increased risk for occupational exposure to tuberculosis in comparison to non-embalming funeral home personnel. These results are similar to rates noted in our pilot study and also support recent reports that indicate that funeral directors and other funeral-service employees may be at an increased risk of tuberculosis mortality.[19,20,21] Our data are consistent with other published tuberculosis prevalence data on health care workers and the general public in that the rate for the licensed embalmers is similar to data for health care workers, and the non-embalmer rates are similar to those found in the general public.[30–33] The association in licensed embalmers between tuberculin reactivity and the number of years worked in preparation rooms is interesting and probably reflects cumulative exposure. The lack of association with respiratory protection probably reflects the lack of past consistent use of effective respiratory devices.

The results of this study point to several important recommendations. First, given the relatively high percentage of licensed embalmers who were tuberculin reactors, and the fact that only a small percentage of funeral home workers reported tuberculin skin testing on an annual basis, it is recommended that testing be conducted annually on licensed embalmers. Second, since funeral home employees may be at increased risk of developing tuberculosis, it is important for them to receive initial training on tuberculosis upon employment and periodic updates as new information becomes available. Third, since the benefit of using adequate respiratory protective equipment has been documented in other health care worker populations, it is recommended that funeral homes provide for adequate respiratory protection of embalming personnel whenever known or suspected tuberculous-infected deceased-human remains are embalmed. Since most embalmers claim to know the tuberculosis status of the deceased-human remains known or suspected to be infectious for tuberculosis beforehand (based on medical history), it should be feasible for them to adequately protect themselves.

There is a potential occupational risk of exposure to tuberculosis related to the visitors to the funeral home. This, in some ways, is similarly shared by hospitals and other health care facilities (with respect to waiting rooms and emergency departments). Therefore, measures that have been found useful in these settings, such as adequate ventilation and providing visitors with tissues to cover their mouths when they cough, may also be of use in the funeral home setting. Of interest was the finding that many embalmers reported recent overall ventilation improvements in their facilities.

There are several limitations to these findings. First, because the study sample was composed of employees attending a national conference, rather than a random sample of employees, the extent to which our results can be generalized is uncertain. However, data on the demographic profile of participating attendees was compared with data on non-participating attendees, as well as to the NFDA membership as a whole, and found to be very similar (data not shown). Second, attendees who previously had positive tuberculin skin tests may have been less likely to participate, and thus our test results might underestimate the true rate in this population. On the other hand, some embalmers who recently tested negative might have felt that it was unnecessary to participate. A third limitation concerns the potential inaccuracies related to the reporting of risk factors. There is the methodological concern regarding the collection of retrospective data regarding past exposures, respiratory-protection use, and past work practices. We had asked embalmers about events that occurred in the previous 12 months. However, tuberculosis infection might have occurred in the recent or remote past. Therefore, inferences need to be made with caution.

This study provides evidence that licensed embalmers may be at increased risk of infection with tuberculosis in comparison with non-embalming funeral home employees. Further studies on the incidence of reactivity (ie, conversion rates) in licensed embalmers are essential in elucidating the problem of tubercu-

losis exposure in this group of health care workers.

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