CASE REPORT

Parenchymal asbestosis due to primary asbestos exposure among ship-breaking workers: report of the first cases from Bangladesh

Venkiteswaran Muralidhar,¹ Md Faizul Ahasan,² Ahad Mahmud Khan³

¹Department of General Surgery, Sree Balaji Medical College and Hospital, Chennai, India

²Central Medical College, Comilla, Bangladesh

³John Hopkins University-Projahnmo, Dhaka, Bangladesh

Correspondence to

Venkiteswaran Muralidhar, muralidharv@gmail.com

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SUMMARY

We report for the first time asbestosis among ship-breaking workers of Sitakunda in Bangladesh who were exposed to asbestos during ship-based and beach-based operations for at least 10 years. Asbestosis was present among 35% of workers. Years of work (>20) and forced vital capacity (<80% of predicted) were significantly associated with the disease. Currently, global ship-breaking operations are mainly concentrated in the Indian subcontinent, and Bangladesh has the majority share. Ninety per cent of domestic steel is produced in the ship-breaking operations in Bangladesh and is an important contributor to the economy. It also gives employment to more than 100 000 people. It is imperative to medically check up all the workers for benign and malignant diseases causally related to asbestos among these vulnerable population of workers.

CASE PRESENTATION

A 45-year-old worker was seen at the clinic with complaints of grade 2 dyspnoea. His family was from North Bangladesh and has been working in the shipyards of Sitakunda, Bangladesh, for 22 years. He had worked in ship-based cutting operations and beach-based operations. He gave a history of exposure to asbestos in both the jobs. He lived in a small shed made from materials procured from the ship close to the place of work. He was a non-smoker. He gave no history of chronic bronchitis or taking bronchodilators. His medical history and family history were not significant. On clinical examination, he had no clubbing and vital signs were normal. On deep inspiration, rhonchi could be elicited on auscultation. Rest of the clinical examination was normal. His basal pulse oximetry and exercise pulse oximetry were normal. Pulmonary function tests revealed that his forced vital capacity (FVC) was 76% and forced expiratory volume in 1 s (FEV₁) was 75% as expected for his age and height. Chest PA X-ray revealed reticular opacities of type signs and symptoms (s/s) with a profusion of 1/1 as per International Labour Organization (ILO) classification. A diagnosis of asbestosis was made.

Methods

The data were collected during two diagnostic medical check-up camps for asbestosis, of 4 days each between July 2016 and January 2017,

organised by Bangladesh Occupational Safety, Health and Environment Foundation (OSHE), a non-governmental organisation. OSHE, established in 2006, is involved in improving the working conditions of garment workers, recording of occupational injuries and accidents, and interacting with all stakeholders related to workers' occupational health and safety. It has also been working for improvement of workplace safety in the ship-breaking industry at Chittagong.¹

Doctors visited the workplace and observed asbestos exposure during both ship-based and beach-based operations. Documentation of asbestos exposure was done by photographing, using a small mobile camera (figure 1). Workers were contacted by OSHE through a worker representative and explained the aim of the medical check-ups, which was to diagnose lung disease causally related to asbestos exposure. Workers with 10 years or more of exposure to asbestos, who had worked mainly as cutters and fitters in ship-based operations and who were willing to come for the medical check-up were selected. The medical check-up was done without the knowledge of the owners to avoid adverse repercussions to the workers. Data were recorded in a dedicated pneumoconiosis questionnaire as done previously.² The questionnaire has detailed occupational exposure history, symptoms of chronic lung disease and relevant history. Clubbing and presence of end-expiratory rales and rhonchi were recorded. Pulmonary function test was done using the Hygeia spirometer, and FEV₁ and FVC were recorded. Predicted values of FEV₁ and FVC were calculated as explained before in a similar study of asbestos-exposed workers in India.² X-ray chest PA view was taken and read as per ILO guidelines. Pulse oximetry, basal and post exercise, was recorded. The data were entered in MS Excel, and χ^2 test was done to test statistical significance. $P < 0.05$ was considered significant.

Diagnosis

Asbestosis was diagnosed if it satisfied the following criteria:

1. History of exposure for 10 years or more.
2. ILO X-ray reading shows reticular opacities (s, t, u) with a profusion greater than 1/1.

Results

The results were tabulated (table 1 and figures 2 and 3). Ninety-nine workers came for

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Figure 1 Mobile camera image during site visit by the authors. A boiler covered with asbestos is undergoing a beach-based operation of dismantling.

the medical check-up. Five workers were excluded since they had less than 10 years of exposure to asbestos, hence 94 cases were taken up for analysis. There were no women. The average age was 38 years. Forty-two workers (44%) had an exposure to asbestos for more than 20 years. Asbestosis was diagnosed among 33 workers (35%). Twenty-five workers (26%) had an FVC of less than 80% of predicted and 23 (24%) had FEV₁ less than 80% of predicted.

The association of years of exposure (>20 years) and FVC (<80%) with the presence of asbestosis was found to be statistically significant.

Table 1		
	Years	Number
Age	20–30	24
	30–40	33
	>40	37
Total (n)		94
Years of service	<20	52
	>20	42
Total (n)		94
	Asbestosis	Total
Diagnosis	Yes	33
	No	61
Total (n)		94
	Range	Total
FVC/pred%	>80%	69
	60%–80%	21
	<50%	4
Total (n)		94
FEV ₁ /pred%	>80%	71
	60%–80%	16
	50%–60%	3
<50%		4
Total (n)		94

FEV₁, forced expiratory volume in 1 s; FVC, forced vital capacity.

Figure 2 Cross-tabulation: years of exposure and asbestosis. Numbers above bars represent absolute numbers (n). * χ^2 test: $P < 0.0001$.

Work process

Ship-breaking work involves removal of all materials from the interior of a ship, emptying of fuel and gas, and cutting and transporting of the metal. It is carried out in the dockyard. The work at Sitakunda shipyards is carried out by male workers. Most of the work is done manually. The work can be divided into ship-based and beach-based work. The ship-based work is done by cutters and fitters in closed confines without any protective gears. The beach-based work is manually done to dismantle parts of the ship. The only mechanised process used is during repositioning of the ship on the beach and use of gas metal cutters to split metal casings. The transportation of heavy metals and cables is done manually with rhythmic steps that accompany the musical beats of a singer. Workers are grouped into cutters, fitters, door workers, furniture workers, metal workers, cable workers, paint and oil workers, and female workers. Women only work in the canteens. Apart from these designated occupations, there are loaders and unloaders, rhythmic singers and

Figure 3 Cross-tabulation: forced vital capacity (FVC) predicted per cent and asbestosis. Numbers above bars represent absolute numbers (n). * χ^2 test: $P < 0.005$.

meal providers. All work is done by unskilled and untrained labour. The workers may be given any of the above-mentioned operations by the foreman, depending on the availability of labour at any given moment. The workers live in small sheds in crowded unhygienic conditions close to the workplace. Sheds also contain asbestos materials procured from the ship. Detailed description of the work processes has been documented elsewhere.³

Initial operations are done indoors, in congested closed surroundings with no ventilation. Protective equipments are rarely used. Hazards from one location contaminate another area and affect neighbouring workers.³ For example, asbestos dust spread from a cutting operation on an asbestos-insulated pipe or cable onto a neighbouring worker who may not be working with asbestos directly.

Hazards

Apart from major hazards due to accidents and falls, the workers are exposed to asbestos, Polychlorinated Biphenyls (PCB), lead and a conglomerate of chemicals. Noise and fire are other major hazards. Asbestos exposure occurs during the operations on boilers and turbines, insulation on pipes, asbestos adhesives, asbestos hanger linings, asbestos cloth covers, asbestos valve packings, asbestos mastic under insulation and asbestos in cables.⁴ In ship-breaking operations in Bangladesh, major asbestos exposure occurs during the cutting operations in the confined spaces of the ship. Later on in beach-based operations, exposure to asbestos continues, as it is manually crushed using heavy hammers. It has been observed that workers sit on asbestos amid high levels of ambient air contamination. The raw lumps of asbestos are powdered manually into fine dust, which is then sold in the streets outside the ship-breaking area. Majority of the recycled asbestos is sent to Dhaka.³ Asbestos insulation materials are sold in shops adjoining the shipyards. Hence, workers are exposed directly and secondarily to asbestos.

Demography, sanitation and medical facilities

Most of the workers are migrants from the North Bengal districts of Rajshahi and Bogra, wherein there is widespread poverty and landlessness.⁵⁻⁷ Majority of them are illiterate and unmarried. Most of the workers are younger than 40 years of age, and 10% are children. Food and sanitation facilities are poor. There is no medical facility on site. Majority of them work for more than 10 hours per day. They can avail of an hour of break for lunch, but this time will be deducted from their daily pay.⁶ Some workers are given 1 day weekly off. They are paid US\$1–3 per day depending on the type of work.⁵

GLOBAL HEALTH PROBLEM LIST

1. Globally, the hazardous ship-breaking operations have moved from richer industrialised countries to the Indian subcontinent, where there is poor occupational health and safety at the workplace.
2. Asbestos is a major hazard of ship-breaking operations, and thousands are exposed to this hazard at the workplace in Bangladesh.
3. There are severe limitations in conducting a prevalence study of asbestos-related lung diseases among ship-breakers of Bangladesh.
4. Occupational diseases including asbestosis are rarely reported from Bangladesh.

GLOBAL HEALTH PROBLEM ANALYSIS

Ship breaking global

Approximately 700 ships need to be scrapped every year. Before 1960, the major ship-breaking industries were mainly located in the UK, USA, Germany and Italy. After the 1960s, the industry migrated to middle-income countries including Taiwan, Turkey and Spain. From the 1980s, the industry is monopolised by two countries, India and Bangladesh. Currently, Bangladesh has the major share of the industry.^{7,8}

Bangladesh economy and the ship-breaking industry

In the last decade, the country has recorded gross domestic product growth rates of above 5% per year primarily due to the development of microcredit and garment industries. Although three-fifths of Bangladeshis are employed in the agriculture sector, three-quarters of export revenues come from ready-made garments.⁹ One-third of Bangladesh's population of 150 million people live in extreme poverty. Seventy-three per cent of the population have a purchasing power of less than US\$1.9 per day. Infant mortality is 31 per 1000 live births.¹⁰ The ship-breaking industry employs about 225 000 people directly in the shipyards and indirectly in ancillary operations.^{5,6} It provides nearly 90% of the iron and steel needs of the country, thus saving precious money from imports of steel. Moreover, the government earns about 700 crore TK annually from import duties and taxes on the ship-breaking operations.^{5,6}

Ship-breaking operations in Chittagong

In the 1960s, a marooned ship was taken over by the Chittagong steel company and scrapped. Ship breaking in Bangladesh got formally started after the Karnafully Metal Works Limited took over a Pakistani warship damaged during the 1971 war for dismantling operations. The ship-breaking industry is located along a 7 km coastline of Sitakunda in Chittagong district in southern Bangladesh (figure 4). The industry got a major boost in the 1980s when developed countries, including the UK, Scandinavia, Brazil, Spain and Korea, decided to stop ship-breaking activities due to the deleterious effects on humans and the environment. The Sitakunda coast in Chittagong district, Bangladesh, is suitable for these operations as it has a long intertidal zone, cheap labour and reasonable weather conditions. Currently, the zone of operations extends to about 14 km and consists of 24 major shipyards. Around 60 ships are dismantled annually.⁵ The exact number of workers involved directly and indirectly in the operations

Figure 4 Google Map location: Sitakunda, Chittagong district, Bangladesh. Major ship-breaking yards are dotted along the coast line.

Table 2 Annual asbestos consumption in Bangladesh

Year	Asbestos consumption (tonnes)
2014	12 100
2013	8030
2012	2230
2011	4370

is not available, but it is conjectured to be upwards of 100 000 workers. The ships are mainly cargo, oil tankers or container vessels from many countries, including the UK, Russia, Japan, Bulgaria, Rumania and Korea.^{5 11} The ships weigh between 5000 and 40 000 tonnes and contain approximately 7 tonnes of asbestos. Nearly 90% of the weight of the ship is due to iron and steel which are coated with about 100 tonnes of paints containing chromium, arsenic, lead and other metals.⁵

Asbestos in Bangladesh

There are many types of asbestos and asbestos materials imported into Bangladesh such as article fibre cement, corrugated cement sheets, asbestos panels, asbestos tiles, asbestos tubes, asbestos pipes and pipe fittings and friction materials. Imports are mainly from Australia, Austria, Bulgaria, Canada, China, Cambodia, Denmark, Finland, France, Germany, Hong Kong and India.¹² Table 2 shows data of asbestos consumption (imports and asbestos production and recycling) in Bangladesh.^{13 14} There is no data on the amount of asbestos produced from ship-breaking activities.

Accidents and occupational diseases

There is no official record of accidents and occupational diseases among ship-breaking workers in Bangladesh.¹¹ Accidents and injuries are frequent in shipyards. Thousands have died or maimed in accidents in the past 20 years during the activity of ship breaking. An Iranian tanker exploded on 31 May 2000 killing 50 people. It was reported in the Bangladesh media that 400 people have died and 6000 seriously injured during ship-breaking operations in the past two decades.⁶ It is reported that there is one fatality every week and one non-fatal accident every day in the shipyards.⁵ One study showed that majority (80%) of workers reported eye-, lung-, gastrointestinal- and musculoskeletal-related symptoms.⁵ Asbestosis has been reported in one study conducted in the home village of ex-ship-breaking workers in Bangladesh.¹⁵

Limitations of this study

The sample was biased and may not represent a typical population of workers in the shipyard. The sample size was small and restricted to workers selected by the union who were willing to risk their jobs to come for the asbestosis medical check-up. Only workers who worked for more than 10 years and clearly stated that they were frequently exposed to asbestos were included in the sample.

Accessibility of doctors to the workers at their site of work is extremely limited. Due to job insecurity, workers are reluctant to give information or come for a medical check-up. There is no co-operation from the managers and owners of the shipyards, and the government is very wary of scientific studies of the occupational diseases, including asbestosis among ship-breakers.⁶ The lack of accessibility and cooperation of the owners and the government is similar in the other major ship-breaking location in the world, namely Alang in India.¹⁶

The problem of access to workers and getting a representative sample is a major problem in estimating the true prevalence of asbestosis among ship-breakers in the Indian subcontinent. Of the 405 ship-breaking workers checked up at the Alang shipyard in Gujarat, India, only 2.96% were shown to have lung opacities suggestive of asbestosis.¹⁶ This contrasts sharply with an asbestosis prevalence of more than 50% among US shipyard workers.¹⁷ In order to avert the limitation of accessibility of workers at the site of work, a study was conducted in the villages of North Bangladesh among the ex-ship-breaking workers. The sample was not representative and found no evidence of asbestosis among six workers who had done ship-based work. Among the non-ship-based workers and ex-workers they found that 12% had asbestosis. One of the reasons for a low figure of asbestosis, the study suggested, was probably due to healthy worker effect.¹⁵ This is surprising, since a study in India among asbestos ex-workers showed an increased prevalence of asbestosis as compared with current workers presumably due to the health-worker effect.² It has been reported in many studies that it is not possible to get a correct and validated exposure history among ship-breaking workers.^{15–17} Workers who gave history of asbestos exposure are included in our case study. This cannot be quantified. Like in our case, Indian workers are also rotated through various sections of the ship-breaking occupation.¹⁶ Hence, it is not possible to compare across different work processes with the disease. In our case study, all the workers had performed ship-based operations, but also had involved in seasonal beach-based work. To sum up, the limitations to conducting a proper cross-sectional study of asbestosis among ship-breakers in Bangladesh are due to imposition of a virtual ban by the owners and the government, fear of workers' losing their jobs and a reluctance of doctors in reporting the data. Indeed, the first report of asbestosis from India from an asbestos factory in Mumbai was conducted outside police barricades.²

In spite of the limitations mentioned above, this is the first report of asbestosis among current workers in Bangladesh. It is also the first report of an occupational disease of current workers in the ship-breaking industry from Bangladesh, which accounts for nearly 55% of all ship-breaking operations in the world.^{6 8}

Occupational diseases in Bangladesh

There is paucity of reliable cause-related mortality and morbidity data from Bangladesh. Most of the countries of the world do not have reliable comprehensive and accurate data on occupational diseases, as is the case with Bangladesh also.^{18–20} Recently, occupational diseases were reported from the Kamrangirchar–Hazaribagh slums in Dhaka, where more than 600 000 migrant workers live and work among the tanneries, garment, metal and plastic industries. Reporting of occupational diseases is fraught with difficulties for the medical doctor as it is always sociopolitical.²¹ This problem is global, and doctors are penalised for reporting occupational diseases even in developed countries.²²

There are few reports of asbestosis among shipyard workers from developed countries. Most of the reports are related to increased mortality due to lung cancer and mesothelioma due to asbestos exposure during shipyard work.²³ One of earliest reports of asbestos-related lung disease among shipyard workers was from the naval shipyards in the UK.²⁴ A retrospective cohort study of US shipyard workers from the 1960s showed an increase in lung cancer and mesothelioma causally related to probable asbestos exposure.²⁵ Shipyard workers

from Japan from the 1950s show an increase in asbestos-related diseases.²⁶ US shipyard workers have more than 50% prevalence of asbestos-related lung diseases.¹⁷ One report from Taiwan showed a causal association of mesothelioma and ship-breaking work.²⁷ As mentioned earlier, reports of asbestosis among ship-breakers from the Indian subcontinent are fraught with limitations. Taken together, they show that there are extremely few reports of asbestosis among workers involved in ship-based breaking operations.

Law

The Bangladesh Ship Breaking and Recycling Rules 2011 have been formulated in pursuance of the Supreme Court order to the writ petition number 7260 of 2008 dated 24 May 2011. The rules are to be administered by the Ministry of Industries with the help of inspectors. The Department of Environment examines the ship for hazardous waste and inbuilt hazardous and toxic materials and issues a certificate. As per Section 15.2(b), an asbestos handling, removing and storage unit (negative pressure chamber) needs to be present as part of the minimum facilities as per a ship recycling facility plan in the yard. Wetting of asbestos fibres, vacuum cleaners and personal protective equipment (PPE) need to be used. Ships and yards storing that have asbestos of more than 100 metric tonnes should go for a negative pressure technique. All workers need to be given appropriate PPE. The removal and handling of asbestos dust and fibres need to be done in a wet condition. Onshore removal needs to be done in enclosures with negative pressure. Section 19(h) adds that the asbestos thus removed should be packed in leakproof packets and disposed at secured landfills where it will be processed.²⁸ It was observed that none of these above-mentioned laws are followed currently.^{3 15}

Workers suffering from occupational diseases, including asbestosis, would be compensated by the law. It is mandatory to report occupational diseases. The diagnosis of the disease is to be certified and issued to the patient in order to claim compensation. These laws mandating the doctor to inform the authorities and the patients in writing are similar to the ones in India.^{29–31} Basic occupational health services among the workers and families at the ship-breaking industry can be set up based on a similar model created by the *Medécins Sans Frontières* at a toxic hot-spot location in Dhaka.²⁰

Learning points

- We report asbestosis for the first time among workers who perform ship-based operations during ship-breaking work in Bangladesh.
- Both ship-based and beach-based operations on dismantling the ship lead to significant exposure to asbestos, leading to asbestosis among the workers.
- Bangladesh is the leading country in the world for the largely unregulated ship-breaking industry, which is an important contributor to the the countries' economy and employment for more than 100 000 workers.
- It is urged to conduct medical check-ups to diagnose and treat benign and malignant diseases causally related to asbestos among these vulnerable population of workers.
- A basic occupational health services must be set up among the community of ship-breakers and the family similar to the *Medécins Sans Frontières* model.

organising the medical camps, medically examined patients and suggested edits to the manuscript.

Competing interests None declared.

Patient consent Detail has been removed from this case description to ensure anonymity. The editors and reviewers have seen the detailed information available and are satisfied that the information backs up the case the authors are making.

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Contributors VM planned the study, organised it, diagnosed asbestosis, analysed the data and wrote the manuscript. MFA and AMK visited the site, helped in

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