



An Overview Of The Health Risks Associated With Beedi Rolling In India, A Low-Paying Occupation With A Substantial Public Health Risk

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ABSTRACT

The beedi industry is important in rural development because of its ability to provide potential employment possibilities to a vast number of people. Ambient monitoring found that the inspirable dust concentration in the tobacco factory was 150-fold greater than in the control environment, and was linked to chronic bronchitis in workers. The elevated amounts of cotinine, thioethers, promutagens, and direct acting mutagens in employees' urine indicated increased systemic exposure to tobacco ingredients. In tobacco processors' target and non-target cells, there was a considerable increase in chromosomal damage. Given the link between tobacco use and a variety of noncommunicable diseases, the current study's findings show an urgent need to reduce cigarette exposure among processors. Because the beedi industry is almost entirely unorganized, even government officials find it difficult to police the many legal requirements. Aside from the legal implications, the health risks that the female employees who roll the beedis suffer are tremendous. The purpose of this research is to look into the health risks faced by female beedi rollers in India.

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Keywords: health hazards, chromosomal damage, tobacco, beedi industry, female beedi rollers

Introduction

Traditional though unhealthy occupation

Labor-oriented productions are on a continuous move towards automation, mechanization and, now-a-days, to digitization (Subeesh & Mehta, 2021). Nevertheless, the general awareness about occupational safety, occupational and environmental hazards are not so much cared for till date in India. Mostly poverty, lack of education and awareness regarding health hazards of occupations, poor nutrition and climatic proneness to epidemics intensify the health adversities among the *beedi* rollers (Vilanilam, 1980). Therefore, on one hand, when the growing automation and digitization are increasing the burden of chronic conditions like obesity and related morbidities, at the same time, there are still some traditional labor-based occupations which have been continuing since long past, with the age-old technology and are associated with very high health risks too. *Beedi* industry in India is an example of this latter kind that seems to have more than a century's history (Chowti et al., 2015). One unique public health aspect of this industry is that it affects health of both the consumers and the manufacturers in similar way (Chowti et al., 2015).

The beedi: what it is

A beedi is a short South Asian cigarette that typically consists of a Tendu (*Diospyrox melanoxylon*) or *Piliostigma racemosum* leaf that is knotted with thread at both ends and contains roughly 0.2–0.3g of tobacco flakes. Despite having a severe health risk, it is an inexpensive form of tobacco consumption and very popular among the Indian middle class and poor (Joshi, 2019; Panneer, 2019; Rao et al., 2020). It has a length of 4 to 8 cm, a closed end diameter of 0.6 to 0.8 cm, and a smoking end width of 0.7 to 0.9 cm. The hazardous substances nitrosamines, formaldehyde, acetaldehyde, crotonaldehyde, hydrazine, arsenic, nickel, cadmium, benzopyrene, and potassium are found in tobacco leaves in addition to nicotine (Dharma, 2009; Services, 2018). Nicotine may be absorbed by all the body tissues including skin, respiratory epithelium, the mucous membrane of the mouth, nose and intestine (Dube and Mohandoss, 2013; Ali, 2018).

The Beedi economy in India

It is a traditional agro-forest based and one of the most labours intensive and predominantly unorganized industries existing in almost all major states of India. The Forest Departments in different states in India monitor the plucking the *Tendu* leaves, their collection, storage and distribution among the *beedi* manufacturers and rollers. On an average, about 750 billion and 1.2 trillion of pieces *beedi* sticks (Sunley, 2008) are annually produced in India. An estimated number of beedi workers are about 4.5 million (Suliankatchi et al., 2019).

However, another estimate claimed this number to be as high as 7 million (Jahangir, 2018) with a majority of home-based women and children engaged in rolling, sorting, checking, baking, labeling, wrapping and packing of *beedi* (Rahman et al., 2018; Ansari and Raj, 2020; Mallick and Satpathy, 2021). It is estimated that the number of permanent *beedi* rollers are 3.5 million along with 0.7 million working on part-time basis. Besides, another 2.2 million tribal workers also depend on collection of *Tendu* leaves as a major economic pursuit⁷. Although most of the states in India have considerable shares of *beedi* workers, the higher proportions belong to Madhya Pradesh (18.3 %), Andhra Pradesh (14.4 %) and Tamil Nadu (13.8%) (Arora et al., 2020).

Studies showed that the *beedi* industries can be divided into organized and unorganized sectors; the formal factory based organised system is only 10% of the total production (Rajasekhar and Sreedhar, 2002b) whereas, the remaining lion share is the contractual or middleman based industry (Nandi et al., 2015) run by the women and children labours (Prasad & Prasad, 1985; Srinivasulu, 1997). Most of these workers belong to the landless poor who are socio-economically deprived classes such as the Other Backward Classes (OBC) as designated by the Governments (Srinivasan and Ilango, 2012). The production of *beedi* generally operates in three systems - factory, outwork and the most common – the contractual system. In this last system, the middlemen/contractor makes the raw material available to the workers, and the latter roll *beedi* at their households and return rolled *beedis* to the contractor (Rustagi et al.).

The scope and objectives of study

Occupational health studies the relationship between the workplace, working conditions, and the health of employees. It aims to improve workers' physical, mental, and social well-being, as well as to support their development and maintenance of working capacity, as well as to prevent and control occupational diseases and accidents, and to eliminate occupational factors and conditions that are hazardous to their health and safety at work (Organization, 2002). Occupational health is an applied discipline of preventive medicine in the sense that it aims to promote health, provide particular protection, early diagnosis and treatment, restrict disability, and provide rehabilitation, among other things (Conditions, 1998). It has now evolved into a multidisciplinary, all-encompassing approach that includes medical, biological, and social sciences. The magnitude and growth of India's beedi business, as noted in the introduction, has sparked scientific interest in determining the true health status of beedi rollers in their socio-demographic context. However, a thorough online search finds that there are only a few studies on the health of these workers. Because of the small number of studies and their focus on certain characteristics, it is necessary to compile all of this research in one place to help the reader comprehend the multifaceted nature of the health hazards of this occupation. The goal of this study is to perform a complete evaluation of the published evidences of beedi rollers' health issues. This study is expected to aid public and occupational health researchers and employees in understanding the health implications and overall burden associated with this traditional labor-intensive occupation.

2. Materials and Methods

2.1. Cross references checked thoroughly

A comprehensive review needs extensive for desired information. To carry out such exploration for data, an extensive online literature search was carried out from January 2017 to December 2018. The following source sites were systematically searched: Google Search, Google Scholar, PubMed, NCBI and ResearchGate. Specific search terms were used singly as well as in different combinations to get available published materials in English. The initial search included a smaller number of terms. However, search results led to the introduction of new terms and so on. All the terms used were noted for record. Finally, the terms included: Beedi, Bidi, rolling, roller, worker, women, children, industry, economy, occupation, occupational, Health, Respiratory, Cardiovascular, Blood pressure, Hypertension, ECG, Heart disease, hematology, mother and child, maternal, pregnancy, pregnant, birth weight, anthropometry, growth, development, mental health, genetic, gene, chromosome, chromosomal, DNA, mutation, mutagen, cytological, physical, posture, skeletal, muscular, musculo-skeletal, pain, back pain. The first five terms were always included as the key terms. No fixed time period was fixed for selecting work. The main criteria of inclusion were studies conducted on *beedi* rollers and any aspect of health. However, to get some background data on the link between smoking and different morbidities, especially those related to pregnancy and foetus, a separate search was conducted. Another study was also conducted to obtain background information on the beedi rollers' socioeconomic conditions and demographic information.

3. Results and Discussion

3.1. Background and working condition of beedi rollers

This enormous unorganized industry, which employs many women and girls at low cost, risk, and liability, is widespread throughout the nation. The majority of beedi labours are from socioeconomically disadvantaged groups including OBC, schedule castes, and schedule tribes (Sabale et al., 2012). In some states, the workers are predominated by the Muslim women¹⁴⁻¹⁶. *Beedi* rolling was reported to generate about 76% of total employment in *beedi* manufacturing industry as a household economy particularly for women (Madhusudan et al., 2014). Women involvement in beedi rolling has been linked to the ease of learning skill, its manual operations, the fact that work can be carried out at home. Poverty, indebtedness, landlessness, lack of alternative skills, little or no access to credit and other means of livelihood compels many women to persist in this occupation (Rustagi et al.). As the job of rolling beedi is believed to require skillful and soft-handed workers, a large number of children are also engaged (Aghi and Gopal, 2001). In rural areas mostly girls and women are easily available for this job as it is probably the best employment opportunity near home for such uneducated people (Kumar Nakkeeran and Bharathi, 2010).

In surveys, the average age of women beedi rollers was 31-36 years (Srinivasan and Ilango, 2013a). Out of 439 individuals, 98.2% were female and averaged 40.8 years (Srinivasan and Ilango, 2013b), according to Madhusudan et al. Socioeconomic factors explain why more women do this career. 63% of female workers chose this career owing to poverty, while 75% were traditionally employed. 66.7% accepted it as a career after marrying at 14-18 years old since their husbands didn't help at home (Srinivasan and Ilango, 2013b). 55% of workers spend 5-10 hours a day rolling and binding beedi, preventing them from spending time with their children (Rajasekhar and Sreedhar, 2002a). Thus, beedi rolling relates health and social concerns, perhaps through attitudes and practices based in poverty, perpetuating a trans-generational cycle of misery.

3.2. Socio-economic condition

The beedi workers come from disadvantaged, underdeveloped, and socially backward segments of society. They continue to be under the direction of the general contractors or subcontractors who provide the raw materials and gather the finished product. These workers are forced to participate in beedi rolling in order to make a meagre living because of the low monthly per capita and the larger family sizes and dependency ratio. The distinctive features of the occupational life of beedi workers include low pay, a lack of security, and inconsistent compensation (Sudarshan and Kaur, 1999). According to a study, the workers received 25–28 INR for every 1000 beedis that were produced (Sabale et al., 2012). The salary may also be insufficient to cover a family's essential necessities on a daily basis (KARTHIKEYAN, 2017). When household income per capita is even lower than 1000 INR per month, it was also estimated that income from this work provided 14–18% of household income. In West Bengal, Madhya Pradesh, and Maharashtra, the majority of beedi dealers and contractors do not abide by the minimum wage laws (Rout et al., 2017). According to a study by

Rout et al. (2017), the prevalence of poverty among beedi rollers was estimated to be as high as 26.4% in urban areas and 18.2% in rural areas (Dhas and Helen, 2008). Beedi workers in India suffer particularly from the lack of a social protection mechanism in comparison to other unorganized sectors (Singh et al., 2017).

3.3. Involvement of child labor in beedi rolling industry

Concerns have also been raised about the fact that children, especially girls, are involved in the process of rolling beedis. The fact that people work from home and get paid by the piece makes it possible for family members, including children, to work. The All-India Beedi Cigar and Tobacco Workers Federation found that between 90 and 95% of all beedi rollers in India are women and children from poor and socially backward communities who work as labours (Singh et al., 2017). Children join the beedi industry because of things like poverty, their parents' lack of knowledge, economic stress, and having a big family (Singh et al., 2017). A study done in the city of Solapur in the state of Maharashtra found that 61% of the child beedi rollers were girls. Of these girls, 7% were totally illiterate, 58% had or were in primary school, and 35% had secondary school. The work hours ranged from less than 8 hours to more than 12 hours, with 10 hours being the average (Kumar, 2021). All of them had to do this work because their finances were bad and it was an easy way to make a living (Singh et al., 2017). In families that roll beedi, girls are usually welcome because they are seen as earning members of the family. When they turn 6 or 7, they start to roll beedi. There is also evidence that when setting up marriages, grooms in these groups care more about how fast the brides-to-be roll their beedis than how much schooling they have (Ghosh et al., 2005). Nicotine from tobacco leaf dust is absorbed by the skin, the lining of the lungs, and the inside of the mouth (Kumar, 2021). High levels of tobacco components like cotinine, thioethers, promutagens, and direct-acting mutagens have been found in the urine of beedi workers. This shows that they are getting more tobacco throughout their bodies (Bhisey et al., 1999). This may lead to chromosomal changes and a higher mutagenic burden (Bagwe and Bhisey, 1993).

3.4. The health hazards of beedi workers

3.4.1. Nicotine exposure and general symptoms

High nicotine and other hazardous substances in beedi tobacco (greater than cigarette tobacco) placed workers at risk for systemic illness¹⁸. Nicotine from beedi tobacco (21.2 mg/g) can be absorbed through the skin, respiratory epithelium, and oral mucous membrane (Malson et al., 2001). During beedi rolling, workers inhale hazardous tobacco dust for 5-6 hours per day, 5-6 days per week (Mittal et al., 2008). Female beedi rollers don't smoke or chew tobacco, but they are exposed to nicotine for lengthy periods of time, which is absorbed through their skin and mucosal membranes into their systemic circulation and aspirated through their noses, causing major health consequences. Unburned tobacco dust enters through the skin and nasopharynx (Bagwe and Bhisey, 1993). Extracts of processed beedi tobacco contained moderately tumorigenic nitrosamines, a powerful mutagen (Govekar and Bhisey, 1992). Increased urine thioether in beedi workers is a surrogate for exposure to alkylating agents⁴⁰. Several investigations found significant cotinine, a detoxified nicotine metabolite and biomarker of nicotine exposure, in beedi workers' urine (Bagwe and Bhisey, 1993). In a recent study, beedi workers had lower total thiol levels and higher serum lipid peroxide/thiobarbituric acid reactive compounds than healthy controls. Duration increased the effect. Thiols make up most of the body's antioxidants and defend against ROS (Jin et al., 2021). Other investigations indicated a substantial rise in serum lipid peroxides in female beedi workers compared to healthy controls (Suryakar et al., 2010). All of these effects in beedi rollers were connected to raw nicotine dust exposure.

Not only are workers' illnesses exacerbated by nicotine and allied chemical exposures, but several other factors, such as an ergonomically unsuitable sitting position for hours, a suffocating single room used as a beedi rolling activity and, in the majority of cases, as their living room, also play a role. Many studies have found that the most common health concerns are musculoskeletal symptoms, respiratory symptoms, neurological symptoms, gastrointestinal symptoms, and ocular symptoms. It is also worth noting that the length of time spent as a beedi worker correlates with the severity of several symptoms. According to Shetty et al. (2020) 65%, 62.1%, and 58.6% of beedi employees with more than 25 years of employment, respectively, suffer from musculoskeletal, respiratory, and gastrointestinal ailments, but just 9% of participants with less than 5 years in this job suffer from musculoskeletal symptoms. Knee joint pain and back pain are two of the most frequent musculoskeletal ailments (Kanagavalli, 2015). Cough, sneezing, dyspnea, runny nose, nasal block, and wheeze may occur as a result of restrictive, obstructive, or combined restrictive and obstructive impairment of respiration (Gopal, 2000). According to research, acidity is the most common GI symptom, whereas headache, sleeplessness, and numbness are the most common brain

symptoms. Vision loss is quite common in cases of eye symptoms (Kanagavalli, 2015). According to one study from the southern part of India, the majority of beedi workers suffered from a wide range of ocular issues, including eye irritation, redness, discharge from the eyes, photophobia, and so on (Mittal et al., 2008). However, additional health symptoms were not included in this investigation. Menstrual abnormalities, constipation, and anemia-like symptoms were also observed in some workers, according to Joshi et al. (2013).

3.4.2. Changes in the risk profile of cardiovascular illnesses

Due to persistent exposure to tobacco dust, the lipid profile of female beedi workers changed significantly (Dhotre et al., 2017). Beedi rollers' high nicotine content induces catecholamine secretion, which raises plasma free fatty acids (Dhotre et al., 2017). These fatty acids are responsible for the formation of triglycerides, which are known to cause cardiovascular problems (Venkatesan et al., 2006). A study on a small sample of thirty-five female beedi employees with at least 5 years of experience, on the other hand, found no significant link between beedi rolling and blood pressure or ECG (Ramakrishnan et al., 2013). It is now known that the content of total cholesterol, LDL, HDL, and triglycerides increases significantly in the blood of female beedi rollers, raising the atherogenic index of plasma (Dhotre et al., 2017). Excess nicotine in the bloodstream converts HDL to LDL, raising the latter's plasma content to levels sufficient to cause atherosclerosis⁵⁰. An exhaustive search of internet resources revealed no other research on CVD risk factors among beedi rollers, with the exception of a few other very few that just reported parameters like blood pressure but did not compare them to control groups (Kumar and Gautam, 2015). As a result, the occupational influence of beedi rolling on CVD risk factors has yet to be examined systematically among beedi rollers in India.

3.4.3. Hematological alterations

Beedi workers are more likely to suffer from a variety of haematological illnesses (Yasmin et al., 2010). Several studies have indicated that beedi rollers had significantly lower hemoglobin and RBC counts (Dhotre et al., 2017). Several investigations on female beedi rollers found significantly reduced WBC and platelet counts. MCV, MCH, MCHC, and WBC differential count levels were also significantly lower in comparison to control participants (Yasmin et al., 2010). Beedi rolling women had lower hemoglobin levels, which, when combined with other haematological abnormalities, may increase the risk of cardiovascular disease and systemic sickness. Other reports back up the aberrant haematological parameters of female beedi workers caused by tobacco dust (Yasmin et al., 2010).

3.4.4. Reproductive and teratogenic impact on woman beedi rollers

Direct smoking, passive smoking, tobacco chewing, and inhaling tobacco dust can damage pregnant women. Smoking during pregnancy impairs foetal growth and development⁵⁵⁻⁵⁸ and increases perinatal morbidity and mortality. Placenta concentrates nicotine, and foetal circulation has 15% more than maternal (Lambers and Clark, 1996). Amniotic fluid is reabsorbed by foetal skin and GI tract. Nicotine has multiple effects on embryonic development. It reduces trophoblast mitotic potential and causes inappropriate early placentation (USDHHS, 2001). It tightens uterine and umbilical arteries (USDHHS, 2001). Chronic exposure raises uteroplacental vascular resistance and alters villous formation, causing foetal hypoxia (Xiao et al., 2004). Nicotine has been linked to foetal growth-related DNA methylation and gene expression (Janssen et al., 2017). Several studies have examined the effects of smoking during pregnancy, including infertility, sub-fertility, ectopic pregnancy, low birth weight, stillbirth, and premature birth (Rogers, 2008). Smoking during pregnancy increases spontaneous abortion risk⁶¹. Non-smoking pregnant women exposed to ETS have low birth weight babies and other harmful effects, though less severe than active smokers (Gupta and Sreevidya, 2004). Non-smokers who use tobacco are likewise prone to low birth weight (Sardesai Suman et al., 2007).

Although women don't smoke much in South-East Asia and India, tobacco dust from beedi rolling could affect their health during pregnancy (Sardesai Suman et al., 2007). Comparatively few research has examined the impact of unburned tobacco dust on pregnant beedi rollers. A prospective study of beedi rolling pregnant women in Karnataka found hypertension and foetal development retardation were greater. The neonates born to these mothers had lower mean birth weight, length, and head circumference, and a significant proportion were tiny for gestational age (Shenoy et al., 2020). Another study in Karnataka found decreased birth weight in beedi roller infants (Astagimath and Veena, 2019).

3.4.5. Tobacco induced genotoxicity, DNA damage and chromosomal aberration in beedi rollers

When beedi is processed, tobacco dust and a number of toxic chemicals, such as nicotine, nitrosamines, polycyclic aromatic hydrocarbons, formaldehyde, and hydrogen, are released into the environment. Nicotine is the most dangerous of these chemicals for beedi workers. High levels of tobacco components (such as cotinine, thioethers, pro-mutagens, and direct-acting mutagens) have been found in the urine of beedi workers, which shows that they are getting more tobacco throughout their bodies (Bhisey et al., 1999). Cytogenetic analysis has shown that this could cause tobacco processors to have more chromosomal mistakes and more mutations (Bagwe and Bhisey, 1993; Mahimkar and Bhisey, 1995). Increased levels of cotinine in the urine micronucleated buccal epithelial cells, and thioethers in the urine are also signs of the mutational load of beedi workers (Hegde and Kamath, 2014).

According to Umadevi et al. (2003), tobacco dust caused chromosomal aberrations (CA) in the form of chromatid breaks and chromosome breaks in peripheral blood cells of male tobacco factory workers (Sundaramoorthy et al., 2013). Khanna et al. (2014) used the Comet Assay to demonstrate an elevated percentage of CA among beedi rollers, with the frequency of total CA being 3.1% as opposed to 1.5% in a control group of those 75 years old or older. In a different study, the frequency of total chromosomal aberration among beedi rollers is 6.85 ± 2.67 , compared to 3.77% in the control group, where the frequency is 1.89 ± 1.31 (Bagwe and Bhisey, 1993). The proportion of CA was 13.7%. Other researchers, including Mahimkar and Bhisey (1995) who found considerable metaphasic chromosomal abnormality in non-smokers who processed beedi, also corroborated this conclusion.

Studies are also necessary among the *beedi* rollers to find out the pattern of diseases associated with smoking and generally caused by specific gene mutations or polymorphisms. For example, comprehensive study on polymorphic variants of CYP1A1 gene may be conducted to assess the risk of cancer in *beedi* workers, because CYP1A1 polymorphism is associated with various tobacco induced cancers viz., lung cancer (Chen et al., 2006) head and neck cancer as well as DNA damage (Sawant et al., 2016).

3.4.6. Oxidative stress and antioxidant defense capacity in beedi rollers

Beedi workers had a favorable connection between urine cotinine and antioxidant defense capacity. Glutathione peroxidase, glutathione reductase, and catalase activity decreased (Suryakar et al., 2010). This decreased total antioxidant capacity increased with prolonged tobacco dust exposure (Suryakar et al., 2010). When beedi workers inhale tobacco dust, they release ROS and free radicals. Reduced antioxidant capability and increased ROS caused oxidative stress in beedi workers (Sawant et al., 2016). This may threaten the pregnant mother and her foetus through lipid peroxidation, which produces H_2O_2 due to insufficient catalase as a scavenger (Sawant et al., 2016). Free radicals and a lowered antioxidant defense system cause several health concerns, including cancer (Devasagayam et al., 2004).

3.4.7. The ergonomically disadvantageous posture

Incorrect sitting posture during long working hours makes beedi workers extremely prone to musculoskeletal disorders from a young age (Rajasekhar and Sreedhar, 2001). A study found that beedi employees sit long hours with their trunks leaned forward, use their fingers excessively, and experience mental stress to accomplish targets. This causes health risks that reduce life quality (Rajasekhar and Sreedhar, 2001). Continuous back muscle stiffening with little or no body movement can cause chronic head, neck, limb, and back aches. 59% of women in Mangalore have musculoskeletal complaints, while 48.3% in Trichy, Tamilnadu, 'feeling dissatisfied due to physical discomfort' (Buvaneswari and Sridevi, 2008). In Solapur, Maharashtra, 87% of 9-14-year-old beedi rollers reported headache and body pain, while in Amarchinta, Andhra Pradesh, 90% of adult employees complained shoulder, back, and neck pain (Joshi et al., 2013). No extensive investigation has been done on ergonomic impacts on body and growth pattern of these youngsters compared to normal children.

4. Limitation of the Study

The absence of systematic review techniques is one of the study's weaknesses. But after a thorough search, it seemed as though all the published resources that were accessible online had already been looked into. The other offline resources, if any, remained outside the scope of the study because it only examined information that was accessible online. Last but not least, this review study was limited to research that were published in the English language.

5. *Relevance of the Study*

According to the present authors' knowledge, this is the first review article to have also covered their socioeconomic background. This study will not only help researchers and public health professionals understand the health issues connected to this line of work, but it will also enable them to do more research in the areas where the study identifies knowledge gaps.

6. *Conclusion*

According to the review, beedi workers labor in a tobacco-dust-filled, toxic workplace. They endure a number of medical issues as a result of their ageing and the extension of their beedi rolling. Musculoskeletal, cardiovascular, and respiratory disorders are most common, along with GI, haematological, ophthalmic, menstrual, and anemia. Genotoxicity, DNA damage, and chromosomal abnormality are major impacts that need more research. Although rare, the evidence addressing the influence on reproductive and birth outcomes in the case of beedi rolling women is substantial. Additionally, there is a great paucity of scientific studies on the general state of these workers' health. Most health-related research were descriptive. Beedi staff exclusively. It was unable to tell if the morbidities were caused by the work hazard, community status, or other factors. In most investigations, the sample size was too small to draw any relevant findings. Case-control research can solve this problem. There is few research on the effects of tobacco dust on pregnant beedi rollers, their foetus, and infants, and none on their future growth and development. No one knows how children of beedi roller mothers or kid beedi workers grew up.

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Conflict of Interest

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