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ORIGINAL ARTICLES

Shade Tobacco and Green Tobacco Sickness in Connecticut

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The prevalence of Green Tobacco Sickness (GTS) among shade tobacco farmworkers in Connecticut is unknown. We conducted a study to determine the

prevalence of GTS in farmworkers working in shade tobacco fields who presented for clinical care at medical student-run clinics. A retrospective chart review of the tobacco workers seen at Farmworkers' Clinics during 2001 was instituted in this study. Although GTS was not clinically diagnosed in any of the patients, we found 15% diagnoses that could be attributed to possible GTS by ICD-9 code review. Using a stricter GTS case definition, the frequency rate decreased to 4%. Nonsmokers were significantly more likely than smokers to report GTS-like symptoms ($P < 0.01$). Isolated symptoms of headache and dizziness were significantly more frequent among nonsmokers than smokers ($P < 0.05$). In conclusion, cases of possible GTS were found in Connecticut shade tobacco workers. Nonsmokers were more at risk to have possible GTS than smokers.

Introduction

Asyndrome known as Green Tobacco Sickness (GTS) has been reported in workers who cultivate and harvest tobacco. Weizenecker and Deal ^[1] first described this disease among tobacco workers in Florida. Since this initial report, the cause of GTS has been attributed to acute nicotine poisoning after dermal contact with mature tobacco plants. ^[2] GTS is usually a self-limiting illness characterized by a constellation of nonspecific symptoms, including primarily nausea or vomiting and headache or dizziness. ^[3] In addition, workers may present with symptoms, such as weakness, increased sweating, abdominal pain, diarrhea, palpitations, and increases in blood pressure. Hospitalization for dehydration, cardiovascular instability, or seizures has been reported in severe cases. ^[2] ^[4] GTS may be common in persons who work in the tobacco fields, although ascertaining precise figures is limited by the nonspecific nature of the symptoms. Estimates of GTS prevalence range from 9% to 41% among tobacco workers. ^[1] ^[3] ^[5] ^[6] ^[7] ^[8] Consequently, GTS is believed to account for significant morbidity, increased utilization of health care, and loss of time at work among tobacco workers. ^[5] ^[9] ^[10]

Although the true prevalence of GTS among tobacco workers is unknown, it is clear that tobacco cultivators have significant occupational exposure to nicotine. Researchers have assessed overall nicotine exposure by measuring salivary cotinine, the major metabolite of nicotine, which has a half-life of approximately 20 hours. ^[11] Higher cotinine levels in workers during the harvest season compared with the early planting season are likely the result of harvesting and handling the tobacco leaves, which provides the opportunity for transdermal absorption of nicotine. ^[12] Tobacco workers often carry the picked tobacco leaves under their arms near the axilla.

Handling of the leaves in this manner enhances transdermal absorption because the moist axillary skin is much more permeable to nicotine, by a factor of 3.6, when compared with the ventral forearm skin absorption. ^[13] Besides seasonal variation and smoking status, other significant predictors of elevated cotinine levels in **farmworkers** include older age and wet working conditions. ^[3] Dermal exposure to nicotine is most severe when the tobacco plants are wet and when the workers' skin is not covered with protective clothing. ^[2]

Studies that have documented GTS prevalence rates in tobacco **farmworkers** have assessed workers who harvest tobacco that is used to make cigarettes. The major varieties of tobacco grown in the Connecticut River Valley shade tobacco fields are used to wrap cigars. The methods used to cultivate and harvest cigar wrapper tobacco differ significantly from the methods used to cultivate and harvest cigarette tobacco. Harvesting tobacco for cigarettes appears to involve more dermal exposure than harvesting the tobacco intended for cigar wrappers. Consequently, there may be a different prevalence of GTS symptoms in shade tobacco **farmworkers**.

In light of the differences between the shade tobacco agricultural process and the process used to grow cigarette tobacco, the purpose of this investigation was to evaluate the possibility of GTS among Connecticut shade tobacco field workers. Because tobacco workers who smoke may be tolerant to nicotine, we also investigated possible GTS in smokers compared with nonsmokers.

Shade Tobacco Work in Connecticut

The tobacco varieties grown in the Connecticut River Valley include Connecticut Valley Shade Grown (cigar wrappers) and Connecticut Broadleaf/ Connecticut Havana Seed (cigar binders). ^[14] The workers in this study harvested shade tobacco. In 2001, Connecticut River Valley Farmers harvested 1300 acres of shade tobacco (2 million pounds) and 2150 acres of broadleaf/Havana seed tobacco (3.9 million pounds). ^[15] In addition to local workers, migrant and seasonal **farmworkers** from Puerto Rico, Mexico, Jamaica, and several Central American countries harvested tobacco in the Connecticut River Valley. There were an estimated 7000 tobacco workers in Connecticut during the 2001 growing season (State of Connecticut Department of Labor, Equal Opportunity Monitoring Unit, Walter Montes, personal communication).

Growing shade tobacco begins in the spring. Extremely small tobacco seeds (10,000

seeds/teaspoon) are planted in pots with automated equipment. The potted seeds grow to seedlings in greenhouses. In the late spring workers plant these seedlings in shaded fields. As the plant grows, workers sucker the plant and tie a string from the plant to an elevated line. "Stringing" the plant prevents the tobacco stalk from breaking on windy days. As the plant grows to maturity, workers wrap this string around the rapidly growing plant. In mid-summer, when the plant reaches maturity, workers harvest the large leaves, starting from the bottom of the plant. To prevent the harvested leaves from becoming blemished, workers place the leaves on the plastic conveyor sheets that they have pulled behind them into the field. As a coworker rolls up the sheet at the edge of the field, the picked leaves are stacked in bins.

The bins of tobacco leaves then are transferred to sheds. In the sheds workers "sew" the tobacco into "bents" of 20 to 30 leaves. The "bents" of tobacco are hung ("racked") in the shed to cure. The cured tobacco is sent to distributors that will use the shade tobacco leaves for cigar wrappers.

Although workers handle the tobacco leaves with care, they have some dermal contact with the leaves and the sap that drips from the stems. During the harvest season, field workers handle the leaves when they pick them. Although they do not carry the leaves under their arms (ie, like the workers who cultivate the tobacco used for cigarettes), they balance the leaves on their forearms before they transfer them to the conveyor. Because of the minimal space between rows, workers brush against the plants when they enter and exit the fields. To minimize dermal contact with the leaves, some shade tobacco workers wear long-sleeved shirts or plastic bags to keep the sap from touching their skin. Because the leaf will be used as the cigar's outer wrapper, shade tobacco cannot become blemished. Wet tobacco blemishes more easily. As a result, shade tobacco workers rarely harvest wet tobacco leaves. In the sheds workers handle the leaves when they sew and rack them.

Methods

Shade tobacco farm workers from five different farms received medical care at the University of Connecticut Farmworkers Clinic Project during the summer 2001. The University of Connecticut Farmworkers Clinic Project was started 4 years ago in response to medical student interest in meeting the health care needs of the migrant and seasonal farmworker population in the State. This program provides

primary clinical care for this underserved population.

A retrospective chart review of the shade tobacco farmworkers who sought medical care at the primary care clinics was used to identify possible clinical cases of GTS from the summer of 2001. Institutional research board approval was obtained before the chart review was started. Demographics, including country of origin but not race, were abstracted from charts.

Three chart review approaches were taken. For the first review, all work-related cases that were reported to the occupational illness surveillance program were reviewed and aggregated for frequencies of the most common diagnoses including any cases of GTS. Because the GTS case definition is vague, for the second review we aggregated for frequencies the clinicians' assigned ICD-9 Codes (American Medical Association International Classification of Diseases, 9th Revision, 1st edition, 2002) for gastroenteritis, viral illness with abdominal symptoms, dehydration, mild hypertension, gastritis, dyspepsia, headaches, palpitations, and abdominal pains as potential cases of GTS in tobacco farm workers. The third review went beyond the clinicians' assignment of an ICD-9 code. All of the charts were reviewed by two of the authors (M.T.C. and M.K.) for possible complaints of GTS using the strict case definition by Arcury et al. [3] Reporting of any nausea or vomiting and headache or dizziness while working with tobacco established possible GTS. Isolated symptoms of possible GTS also were reviewed. A standardized intake form prompted clinicians to ask smoking status. Subjects with any current smoking noted in the chart were considered smokers. Smoking was analyzed for relationships with possible GTS, possible GTS isolated symptoms, and the number of visits made to the clinics using chi-square tests of significance.

Results

During the 2001 growing season, there were 450 clinic visits by 331 shade tobacco workers who sought medical care during 25 evening clinics or health fairs at five different tobacco farms. The demographic characteristics of the farmworkers are shown in [Table 1](#). All subjects were male and predominantly Jamaican or Hispanic from different countries, mostly Puerto Rico and Mexico. [Figure 1](#) summarizes the number of ICD-9 diagnoses codes, the number of subjects with ICD-9 coded visits, the number of subjects seen in the clinics, and the total number of clinic visits.

Table 1. Demographic Characteristics (N = 331)*

Farm (n)	Mean Age (SD)	Age Range	Country of Origin								Smokers N (%)
			US	Jamaica	PR †	DR ‡	GM §	MX 	CR ¶	Missing	
1 (86)	39.3 (10.4)	18–71	0	47	30	5	1	0	0	3	36 (41.8)
2 (107)	33.4 (12.7)	16–76	0	0	16	1	1	85	1	3	32 (29.9)
3 (89)	41.8 (10.7)	19–68	2	40	39	5	0	0	0	3	33 (37.1)
4 (39)	41.0 (12.1)	19–68	1	22	14	2	0	0	0	0	25 (64.1)
5 (10)	31.0 (17.3)	19–69	0	0	0	0	6	3	1	0	1 (10.0)
Total (331)	37.9	16–76	3	109	99	13	8	88	2	9	127 (38.4)

* Demographics of all patients seen in Farmworkers' Clinics, summer 2001

† PR, Puerto Rico;

‡ DR, Dominican Republic;

§ GM, Guatemala;

|| MX, Mexico;

¶ CR, Costa Rica.

Fig Retrospective chart review

Of the 41 work-related incidents reported, the primary diagnoses were categorized as musculoskeletal, including sprains/strains, DeQuervain's tenosynovitis and muscle spasm (39%); allergies, irritation or rhinitis (22%); or dermatitis (22%). No clinical cases of occupational nicotine poisoning were reported during the summer of 2001.

A retrospective review of the ICD-9 codes for the migrant and seasonal workers seen from shade tobacco farms in the summer of 2001 demonstrated that of the 432 ICD coded diagnoses there were 53 (12%) visits, 45 primary and 8 secondary diagnoses, that could be categorized as possible GTS (53 of 432 visits). Of note, an ICD-9 code for nicotine poisoning (not insecticide) exists; however, no worker's symptoms were assigned this ICD-9 code. Only one of the 8 individuals with a secondary diagnosis consistent with possible GTS had also a primary diagnosis that might be due to this syndrome. There were 45 primary diagnoses made on the 303 workers seen with ICD-9 coded visits that could be consistent with possible GTS syndrome (Table 2). This corresponds to 15% (45 of 303) workers with possible GTS.

Table 2. Subjects with ICD-9 Codes Consistent with Possible GTS*

Primary Diagnosis	ICD-9	N	Secondary Diagnosis	ICD-9	N
Dehydration	276.50	3	Hypertension mild	401.90	4
Hypertension-mild	401.90	20	Gastritis	535.50	1
Gastritis	535.50	4	Dyspepsia	536.80	1
Dyspepsia	536.80	4	Headache	784.00	2
Acute G.I.	558.90	1			
Headache	784.00	7			
Palpitations	785.10	2			
Abdominal Pain	789.09	1			
Total		45			

* Data obtained from 432 ICD codes that were generated from 303 subjects who had

ICD-coded visits.

GTS, Green Tobacco Sickness.

Using the stricter case definition of Arcury et al, [3] a third review was completed for all the subjects with clinic visits. Thus, only subjects with nausea or vomiting *and* headache or dizziness, while working with tobacco, were considered as possible GTS. There were 450 clinic visits by 331 different subjects. The number of visits is different from the total number of ICD-9 codes, as many subjects would not be diagnosed with an ICD-9 code anew on repeated visits for refill of medications or other reasons. Using this stricter case definition, there were 13 cases of possible GTS, comprising 4% of all subjects who attended the clinics, all nonsmokers [$\chi^2 (1) = 6.82, P = 0.009$]. Other isolated symptoms of headache [$\chi^2 (1) = 4.86, P = 0.03$] and dizziness [$\chi^2 (1) = 4.12, P = 0.04$] were significantly more frequent among nonsmokers than among smokers. There was no significant difference in number of visits to the clinics between smokers and nonsmokers. There was a trend for nonsmokers to be more likely to report nausea [$\chi^2 (1) = 3.54, P = 0.06$], mild hypertension [$\chi^2 (1) = 2.85, P = 0.09$] and abdominal pain [$\chi^2 (1) = 2.94, P = 0.09$] than smokers. Table 3 describes symptoms among tobacco farmworkers comparing smokers with nonsmokers.

Table 3. Subjects with Possible GTS* or GTS-Isolated Symptoms (Smokers and Nonsmokers), Chart Review (N = 331)

Symptoms	Smokers (%) <i>n</i> , 127	Nonsmokers (%) <i>n</i> , 204	Total	<i>P</i>
Possible GTS	0 (0.0)	13 (6.4)	13	0.009
Headaches	14 (11.0)	43 (21.0)	57	0.027
Dizziness	1 (0.8)	12 (5.9)	13	0.042
Nausea	5 (3.9)	21 (10.3)	26	0.060
Vomiting	4 (3.1)	8 (3.9)	12	0.950

Symptoms	Smokers (%) <i>n</i> , 127	Nonsmokers (%) <i>n</i> , 204	Total	<i>P</i>
Hypertension	13 (10.2)	36 (17.6)	49	0.090
Abdominal Pain	1 (0.8)	10 (4.9)	11	0.086

* GTS was defined as nausea or vomiting *and* headache or dizziness while working with tobacco.

GTS, Green Tobacco Sickness

Discussion

Although GTS was not diagnosed in shade tobacco farmworkers who sought medical care at the farmworkers clinics in 2001, our retrospective chart review data suggests that from 4% to 15% of the workers seeking medical care, while harvesting shade tobacco in Connecticut, presented with symptoms that were consistent with GTS. Additionally, nonsmokers were more likely to have possible GTS symptoms when presenting to the clinic than smokers. These findings suggest that GTS may be an occupational disease among these workers that should be further investigated with biochemical markers such as cotinine levels, a surrogate marker of overall nicotine absorption.

Our study extends the literature by describing the prevalence rate of possible GTS among shade tobacco workers who sought medical care. The rate of possible GTS (4% to 15%) in these workers is lower than the prevalence rate of GTS among workers who cultivate cigarette tobacco (ie, 9% to 41%) and most likely reflects differences in work practices between the more careful methods used to harvest shade tobacco compared to those used to harvest cigarette tobacco. [1] [3] [5] [6] [7] [8] Our lower prevalence rates may point to the successful lowering of transdermal nicotine absorption in shade tobacco fields through different harvesting practices (ie, less direct handling of the leaves and the avoidance of harvesting wet leaves). However, our prevalence rates may underestimate GTS among shade tobacco workers because many of the workers affected by the illness do not seek medical care; this is a

problem likely shared with other studies. [6] [8] Alternatively, it is also possible that we overestimated the occurrence of GTS because the symptoms of GTS are nonspecific, and some individuals with other diseases such as gastroenteritis, viral illness, heat stress or dehydration could have been mistakenly included.

Our data suggests that nonsmokers are more likely than smokers to develop possible GTS symptoms. This finding is consistent with other studies suggesting that nonsmokers may be especially vulnerable to GTS. [6] [8] The reason for this is presumably because smokers are tolerant to nicotine, and therefore are less likely to have symptoms to additional nicotine exposure.

This study has the following limitations: 1) the fact that is retrospective; 2) that it lacks a definitive marker, such as cotinine, to measure nicotine absorption in workers to confirm the diagnosis of GTS; 3) that we reviewed only charts of patients who went to the clinic; 4) that it was impossible to know whether all workers seen in clinic had exposure to tobacco in the previous 24 hours; 5) that it relied on self-reported smoking status; and 6) that is used a strict case definition for possible GTS in one of the reviews, perhaps excluding some cases.

Conclusions

There was a 15% prevalence rate of ICD-9-coded primary diagnoses that could be attributed to at least one symptom of possible GTS among shade tobacco workers seeking medical care. Using a stricter case definition for GTS, we found 4% of the workers who attended at these clinics with possible GTS. Nonsmokers had a significantly higher risk than smokers to develop symptoms consistent with GTS. Further research is needed to improve the quality of life and to prevent diseases in this underserved population of predominantly migrant farmworkers. Occupational diseases, such as GTS, are some of the many problems affecting this group of workers, and implementation of prevention strategies would likely improve their health and well-being. More education about occupational diseases is necessary for students and primary care physicians providing care for farmworkers.

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