PHN PUBLIC HEALTH NURSING

Public Health Nursing Vol. 33 No. 6, pp. 502–510
0737-1209/© 2016 Wiley Periodicals, Inc.
doi: 10.1111/phn.12265

POPULATIONS AT RISK ACROSS THE LIFESPAN: POPULATION STUDIES

Health Concerns of Northeastern Pennsylvania Residents Living in an Unconventional Oil and Gas Development County

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ABSTRACT ***Objectives:*** This study was conducted to describe the health concerns of residents of an unconventional oil and natural gas development (UOGD) community and identify methods to best disseminate health information to the residents. ***Design and Sample:*** A qualitative descriptive study of 27 residents of Wyoming County, Pennsylvania, was conducted. ***Results:*** Residents described their health concerns in terms of their changing community as a result of UOGD, their feelings of stress and powerlessness related to these changes, and the limited response of their local policymakers and protective agencies. There were indications of misinformation related to routine environmental health and UOGD environmental risks. Web-based educational programs with downloadable printed materials to bridge the knowledge gaps of residents and health professionals are recommended. ***Conclusions:*** Recommendations include public health nurses providing education to communities and other health professionals regarding environmental health risks, working with communities to advocate for health-protective regulations, and adopting a community-based participatory approach to meet the needs of community members.

Key words: unconventional oil and gas development, environmental health, fracking, community changes, powerlessness, stress.

Background

Unconventional oil and gas development (UOGD) using high-volume hydraulic fracturing ("fracking") has grown rapidly in Pennsylvania's Marcellus Shale regions since 2008. Fracking methods rely on pumping large volumes of water, sand, and a solution of chemicals into deep wells to release oil and gas trapped in rocks (Kargbo, Wilhelm, & Campbell, 2010). Currently, there are approximately 6,500 active wells using fracking methods in Pennsylvania with projections of 60,000 new wells in the next 20 years (StateImpact PA, n.d.). In addition to oil and gas wells, UOGD includes gathering lines and miles of pipelines that are supported by pig launchers, dehydration stations, compressor stations, metering stations, processing plants, and silica transfer stations. Furthermore, unlike traditional gas extraction, fracking operations have more wells drilled in a close area and large fleets of trucks creating an industrialized effect in rural communities (de Melo-Martin, Hays, & Finkel, 2014).

Health impacts from UOGD range from its effects on the physical environment to social and cultural effects on communities. Water issues have been the most frequently reported as methane from

fracked wells have migrated into private drinking water wells (Osborn, Vengosh, Warner, & Jackson, 2011). There also are reports of contamination of drinking water from leaking fracking fluids (McKenzie, Witter, Newman, & Adgate, 2012). In Northeastern Pennsylvania, residents living within 1 km (0.62 miles) of fracked gas wells were found to have higher concentrations of the hydrocarbons, methane (6 times higher), ethane (23 times higher), and propane (traces) in their drinking water than those who lived further away from a gas well (Jackson et al., 2013).

Air quality problems stem from methane leaks, silica exposures, and the overall industrialization of rural communities (McKenzie et al., 2012). Elevations in ground-level ozone, particulate matter, and aromatic volatile compounds such as BTEX (benzene, toluene, ethylbenzene, and xylenes) have been reported (Wyoming Department of Environmental Quality: Air Quality Division, 2009). In addition, ambient polycyclic aromatic hydrocarbons (PAH), benzo(a)pyrene and phenanthrene, both known human carcinogens, have been found to be elevated in fracking communities (Paulik et al., 2015). PAH levels were highest in areas closest to wells (<0.1 mile), but they were also above Clean Air Act regulation levels at sites greater than 1 mile from a fracked well (Paulik et al., 2015). Infants born to mothers living within a 1.5 mile radius of an unconventional natural gas well were at increased risk of low birth weight (Hill, 2014) and within a 10-mile radius there was an increased risk of congenital heart defects and neural tube defects (McKenzie et al., 2014). Furthermore, a positive relationship has been found between the number and the density of wells (number of wells within a square mile) and frequency of hospitalizations (Jemielita et al., 2015). Known carcinogens such as benzene, formaldehyde, and methylene chloride have also been found in air emissions from natural gas compressor stations (Southwest Pennsylvania Environmental Health Project, 2015).

The importance of their families' attachment to the land, as well as their legacy of passing the land to future generations were important elements to living in rural Pennsylvania (Perry, 2013). However, residents of Northeastern Pennsylvania (NEPA) have attributed UOGD to disrupting their quality of life (Perry, 2013). Since UOGD in NEPA, there have been more noises and dust, new odors, changes in appearance of their water, and new UOGD people in town. Although there was anticipation of economic security with UOGD, there have also been concerns regarding the future of their rural way of life (Perry, 2013). The changes in their community structure and loss of a rural way of life for Pennsylvanian women led to feelings of powerlessness and mistrust of the gas industry, local government, and regulatory agencies (Resick, Knestrick, Counts, & Pizzuto, 2013). The influx of the UOGD workforce has created additional changes in communities. UOGD communities have noted rising rents, increases in substance abuse, motor vehicle crashes, and sexually transmitted diseases (Institute of Medicine, 2014). Furthermore, Pennsylvania residents in UOGD communities have reported increased fatigue, nasal and throat irritation, sinus problems, burning eyes, shortness of breath, joint and muscle pain, severe headaches, sleep disturbances, forgetfulness, irritation, nausea, skin irritation and rashes, depression, anxiety, and dizziness (Steinzor, Subra, & Sumi, 2013).

There has been a notable absence of health-protective and environmental-protective polices related to UOGD. National and Pennsylvania state advisory committees related to UOGD of the Marcellus Shale Play have not included experts in environmental public health (Goldstein, Kriesky, & Pavliakova, 2012). Moreover, state agencies, such as the Pennsylvania Department of Health, have not provided health information or guidance related to UOGD for Pennsylvania residents (Colaneri, 2014).

Wyoming County, Pennsylvania, has a population of 28,000, with a population density of 71.2 people per square mile (U.S. Census Bureau, n.d.). The population is primarily White (97.4%; statewide PA 82.9%). The median household income is $48,626 (PA $52,548), with 12.1% (PA 13.3%) of the county's residents living below the national poverty level and 17.4% (PA 27.5%) of the county's residents earning a bachelor's degree or higher (U.S. Census Bureau, n.d.). The county is relatively new to UOGD compared to other areas of NEPA. In July 2014, Wyoming County had 131 active UOG wells, 214 in October 2014, and as of February 2016, there were 228 (StateImpact PA, n.d.). Compressor stations move the extracted gas through the extensive pipelines in the county. At the time of data collection, the county seat was slated to be the site of a silica (fracking sands) transfer station.

Given the industrialized process of UOGD in rural communities, it is likely that residents living in UOGD communities have environmental health concerns. The literature related to UOGD is primarily related to its environmental impacts with little consideration of health-related concerns of the community residents. When community members are included in the identification of health concerns there is greater community engagement in risk reduction and health-protective interventions (Friedman et al., 2014) and, thus, has the potential for improved community health outcomes (Faridi, Grunbaum, Gray, Franks, & Simoes, 2007). The aims of this study are twofold: first to describe the environmental health concerns of residents of an UOGD community, and second, to identify methods that public health nurses can best disseminate accurate health information to the community residents.

Methods

Design and sample

A qualitative, descriptive approach was used to address the aims of the study. This method provides foundational knowledge of a health problem and is used to understand an issue when there is little known about the area being studied (Sandelowski, 2010). Participants were asked open-ended questions regarding their health concerns, where they get their health information, and their perceptions of the best methods to communicate health information to county residents (see Table 1 for sample questions).

The primary investigator (PI) had personal ties to the region and relied on personal contacts to reach community leaders. Participants were recruited through community leaders (clergy, nurses, elected officials, and community activists), flyers in public areas (restaurants, stores, libraries, and health facilities), and snowball sampling. Potential participants contacted the PI and the study was explained. If they were willing to participate they were encouraged to invite neighbors to the focus group interviews. Inclusion criteria were a resident of Wyoming County, Pennsylvania, adult (18 years old or older), and English speaking.

Five focus groups were conducted throughout the county. Focus groups were held in libraries, churches, and a participant's home. There were 27 total participants (See Table 2). They were primarily female (74%), all non-Hispanic White, and highly educated when compared to the rest of the county with 22.2% completing a bachelor's degree and 40.8% earning a graduate degree. Six of the focus group members previously signed gas leases and six lived within 1 mile of a well. All focus group interviews were audio-taped and verbatim transcripts were generated. Focus groups occurred between July 2014 and May 2015. Investigators protected the rights of human subjects by reinforcing the voluntary nature of participation and requesting that focus group members not share what was discussed during the interviews. The investigators' Institutional Review Boards approved the study.

TABLE 1. *Sample Interview Questions*

How do you view the health of your community?
Do you have any concerns about the health of your community?
What are the factors that you think influences your personal health and the health of your family?
What are the factors that you think influences the health of your community?
Do you have concerns about your personal health or the health of your family?
Do you have concerns about your drinking water?
Do you have concerns about your air quality or air pollution?
Do you have any concerns of environmental harm to the property or natural surroundings?
Do you have any concerns of harm to wildlife or fish?

Analytic strategy

Content analysis included identifying manifest (what is said) and latent (hidden meaning) content (Elo & Kyngas, 2008) for the first research question: What are the health concerns of Wyoming County residents? Only manifest analysis was used for the second research question to identify the preferred learning methods of county residents. Each investigator listened to the audio-taped interviews while they read the verbatim transcripts to enhance latent analysis. Then, the investigators separately identified themes from key phrases and meaning of the phases. Consistency in the identified themes was noted between investigators. Ethnograph (version 6), a qualitative data management program, was used to code the themes from the transcripts. Finally, the PI reread the transcripts to ensure that identified themes covered all that was described in the interviews. Once themes were identified and

TABLE 2. *Demographic Information of 27 Participants*

Gender	Highest education	Annual household income in dollars	Signed lease for UOG well	Distance from home to nearest UOG well
Female = 20	High school: 5	>25,000 = 3	Yes = 6	<1 mile = 6
Male = 7	Associate degree: 5	25,000–49,999 = 6	No = 21	1–2 miles = 3
	Baccalaureate degree: 6	50,000–74,999 = 6		3–4 miles = 1
	Graduate degree: 11	75,000–99,999 = 3		5–6 miles = 5
		100,000–124,999 = 3		12–13 miles = 1
		125,000–149,999 = 1		35 miles = 3
		150,000–174,999 = 1		Don't know = 8
		No answer = 4		

data analyzed, a summary of the findings was sent to 8 participants who shared their email addresses with the PI. Five participants replied that the summary reflected their views of the health concerns and associated learning needs in their county.

Results

Three themes were generated. Two themes related to the social context and health concerns of the participants: changing community and powerlessness. The third theme, health education, addressed participants' preferred methods of receiving health-related information.

Changing community

Participants had strong connections to their community. Their ties to the people and land were from their families' long history in the region or from selecting the area as a place to build a legacy for future generations.

> This is my life. This is my home. These are my friends and family and people that I have loved my life through, and their parents and their parents, because a lot of us are third and fourth generation in this town, so we're all connected.

As a consequence of their community connection, they felt a responsibility to their community and to future generations. They worried about the legacy of UOGD in the region.

> I think that's the biggest thing is that they (the UOG industry) really don't care about us as a community, it's just what they can get out of us. We're gonna pay the cost of it, our children are gonna pay the cost of it, our grandchildren . . . they're the ones that are gonna suffer for it.

Some acknowledged the current economic and employment opportunities and the future of the region. Initially, they were excited by the opportunities UOGD offered their community and their neighbors who were struggling economically.

> To see these people come in and give you a hope of a future and it's like okay I can protect my kids for the future, I can give them something, not knowing they were going to take away their health. Not knowing they were going to destroy the land.

Despite potential economic opportunity, UOGD has led to an industrialization of their rural community. They described constant noise, diesel odor, and disruption of their way of life with heavy pipeline machinery and trucks. One participant reported that her sleep was frequently disrupted as "on average 105 trucks an hour for the last 3 years 24-hr a day" pass by her house. The community changes led to feelings of stress.

> There is no peace there anymore . . . And it's become quite stressful and that spills over into other aspects of your life. So it seems our lives are constantly in upheaval and disrupted by this constant construction. We bought a place in the country that we thought was so quiet.

Participants reported smelling odors when wells were drilled or during emergencies such as a compressor station blowout. One described getting "dry heaves and burning eyes and throat while out driving" in areas of fracked wells and flaring of wells. They described a "sickly sweet" odor to the air that leaves a "pasty residual on your throat." Another shared that, because the location of her house (low in the valley between mountains), she has been awakened during the night:

> The stuff builds up and it gets to my house and I get choked out in my sleep, 4:00 in the morning, I'm coughing, I don't have asthma . . . It was to the point where my throat was burning, my eyes were tearing.

When days were hazy and humid participants reported it was more difficult to breathe outside. They attributed this to the large fleet of diesel-powered trucks that were now a constant part of the community landscape. In addition, there were visible signs of air quality changes that have become increasingly worse in "last 2 or 3 years when it (UOGD) started revving up more in our county." Residents have noted a white haze over the mountains.

Neighborly relations were strained when neighbors received financial benefit from gas royalties, whereas others who did not have gas leases were living with the effects of an industrialized community without economic benefit.

> My whole neighbors, everybody signed, so that's not gonna keep the pollution away from me. There's no boundaries. It's almost like trespassing on my property, the air and water. 'Cause if I was to put my septic sludge on their property, I'd get in trouble, but then I have to breathe the air.

Changes in water quality ranged from concerns about drinking water to contamination of surface waters. Residents acknowledged that methane has migrated into "the water for decades" and methane migration can occur when drinking water wells are drilled. However, with UOGD, there are different water contaminates. Most residents could not afford the $1,000/every 6 months for the more comprehensive water test that is necessary to accurately measure contaminates in UOGD areas. In fact, one participant moved into town to be on the municipal water line instead of incurring the expense of frequent testing of drinking water. Others relied on gas companies testing their water, but those results were viewed with suspicion and considered "the fox guarding the henhouse." In addition, a mother was concerned about a gas pipeline's impact on water quality at her children's school grounds.

> I mean, that's what my kids drink. If they're thirsty, if they have already finished what they brought in their lunchbox, they're drinking out of the water fountains there (at the school).

Community members were also concerned about UOG industry-related spills and described problems with surface water contamination in a rural area of the county.

> We had two big major spills, or blowouts, plus when we went to look at those blowouts I came across a drilling mud spill into the creek right before fishing season, which was supposed to be repaired and it was weeks later and it wasn't.

With a changing community, there were concerns about physical safety. Before UOGD in the region, residents rode bicycles and walked on the rural trails and roads, but now "that is done" because there were safety concerns regarding strangers on walking trails and the trucks "whip by" so fast on the roads. With community changes, walking or bicycling on the roads "you take your life in your hands." In addition, the influx of the gas workforce was changing the culture within the county. There was evidence of people poaching animals and trespassing on their property. Participants also described instances of the UOGD workforce using recreational drugs, such as marijuana, methamphetamines, and excessive alcohol.

Powerlessness

Participants expressed a sense of powerlessness related to changes in the community, stress and anxiety about not knowing what to expect, mistrust of elected and government officials, and concerns for their health. The community was described as "disraveling: coming apart" and the sense that they "have been failed" by the decision makers of their community. For some, the powerlessness and anxiety began when they signed a gas lease for their property. The lower portion of the county had already experienced a "blast" from a release at a dehydration station. This raised concern of not being informed about what to expect in the event of gas-related emergencies.

> They didn't even know. They had an idea that it could blow, but not to the intensity that it blew. It threw one man out of bed. It just shook him right out of his bed. Like a jet engine when it goes off.

People felt uninformed and that they were not getting the answers they need from the UOG industry because "they hold information so close to the chest, everything is played close to the chest."

> I do know there has to be progress. I am not the person that's telling you, "We don't need it. We don't want it," but just tell us what's going on. How do we protect our kids? How do we protect all this?

Their questions stemmed from lack of transparency related to UOGD. They believed that their local policymakers were making decisions without due diligence regarding both the benefits and risk of UOGD in the county or without including the

residents. In fact, some participants described themselves as being misled and "denied information." Powerlessness came from mistrust of the UOG industry and policymakers.

> All you saw was them coming in doing good things and now it's like "Whoa", maybe it's not so good . . . I think now, hindsight, I can't believe that we had a congressman that was from our area that didn't alarm us and warn us and prepare us for what was coming our way, because he was well aware of all of it because of everything in Texas and stuff like that.

Health concerns and powerlessness ranged from environmental exposure risks, such as chemical spills, silica dust, and worker contamination, to long-term health impacts from UOGD and disbelief that this could be happening in their community. Many reported that they did not know enough about the health risks of UOGD. One mother shared:

> I have kids, and they're bringing things out of the ground that never have been (brought out) before, and it (may) not have a direct effect now, but is my daughter going to have some kind of reproductive cancer in 25 years because she has grown up with it (UOGD) in her air? . . . And by the time she's grown up, I don't want that to have been something that affected her and I wasn't aware of it.

Residents were also powerless from environmental exposures when gas workers patronized local businesses before they cleaned themselves up after a day of work.

> These guys, they get off the rigs, they're coated from head to toe, they're on a lunch break. "Oh, I gotta go cash my check." Yeah they go into McDonalds with the chemicals . . . They leave the happy trail of the dust and whatever—All these people are getting exposed. Why? Why aren't they washing the trucks off?

Adding to the sense of powerlessness was the fact that the local, state, and federal agencies charged with protecting the residence were not responsive to the residents' concerns. Residents contacted state agencies such as the Department of Health (DOH) or the Department of Environmental Protection (DEP) with complaints such as "my throat was burning, my eyes were tearing." The DOH would refer them to the DEP and the DEP would not come to investigate the complaint. Powerlessness was also felt with the Pennsylvania regulation that prohibits health care providers from sharing information regarding chemical exposures of patients beyond the sphere of the health providers caring for the patient.

> Then there's this bit with if there's a well on your property or close to your property, and you're not feeling well, and you go to the doctor, the doctor is forbidden to discuss.

Health education

To address the health concerns of the community members, the second aim of this study was to identify methods to best disseminate health information to people living in Wyoming County. Participants shared that early on in the gas boom there was limited information and "then finally we found, on Facebook, we found private boards of people discussing impacts and we went from there and it just blossomed." One community used a team approach to learn about the impacts of UOGD. A few members of the community travelled to Oklahoma and Texas to learn about UOGD and report back to the community. Others did not seek out information until they experienced a personal impact, such as the silica transfer station that was slated be erected in a populated area.

Participants were overwhelmed by the information they found.

> I think this information is so hard to digest for the average person. I know when we've been going through stuff and I'm looking sometimes I have to read a paragraph and I have to walk away.

Many believed that they should not have been responsible to find UOGD health information themselves; instead, it should have been gathered by local policymakers and made available on their websites. Participants requested specific information, such as a health registry to show "crunch numbers" of the health impacts; what is in the fracking fluids so health providers can accurately address health complaints; and specific symptoms that the public should be aware of related to UOGD.

Participants searched the Internet and relied on blogs and listserves such as UOG industry websites, a state university, and an environmental advocacy group. Informational meetings were helpful in navigating the complex maze of information related to UOGD. Newspapers, magazines, radio, and television were also useful in providing information regarding UOGD, but the participants felt that there were times that they were not sure which was accurate because "you're hearing something different on

every channel" and "you don't know who's reliable." A few relied on the peer-reviewed literature.

Lastly, residents identified getting information from trusted experts, such as their physician or family members with expertise in a specific area, such as nursing or chemistry. However, there were instances of misinformation related to health risks of residential radon exposure, monitoring water quality, and human health risks of silica (causes silicosis and a carcinogen).

> So I went to him (primary care doctor) and said, "Help me understand. There's a lot of concern over this (silica). What are the short-term and long-term effects?" Short term he said, none. A generation from now, oh definitely, you might have some asthma.

Information regarding the health impacts of UOGD, websites and printed materials, such as flyers or fact sheets, were identified as favored methods of delivering information. Websites containing informational videos and downloadable printed material were recommended. Community members could print information to refer to later or give the information to someone without computer access. Trustworthiness of the source of information was mentioned to be sure "that it's the truth and not something that's conjecture." Some suggested that the information should come from the Pennsylvania DOH or the Centers for Disease Control and Prevention. Informational sessions at senior citizen centers, schools, faith communities, and township meetings were also suggested to provide health information to community members.

Discussion

The people of Wyoming County are experiencing countywide industrialization from UOGD. Like other UOGD Pennsylvania communities (Perry, 2013; Resick et al., 2013), participants described the impact of UOGD in terms of their changing community related to air and water quality and feeling powerless which contributed to feelings of stress. No formal mechanisms to register health complaints related to UOGD existed at the time of this study (Colaneri, 2014); however, some participants in this study reported health symptoms that have been noted in the UOGD literature (Steinzor et al., 2013). To protect their community, participants have attempted to engage the UOG industry, local government, and state agencies. However, according to many participants, these groups were not responsive to residents' concerns. The "disraveling" of their community and failure of official organizations to address environmental health concerns have led to feelings of powerlessness.

Participants described accessing information from a variety of sources and some sources were more accurate and reliable than others. There is sufficient scientific evidence of environmental health risks for UOGD communities; however, accurate environmental health information related to UOGD and other environmental risks has not been easily accessible to all community members. Among the barriers to information identified in this study was limited access to accurate environmental health resources, lack of trust of the organization providing the information, and feeling overwhelmed by UOGD research findings. Furthermore, in Pennsylvania, there has been a lack of an official public health response to environmental health risks related to UOGD (Colaneri, 2014).

Public health nurses (PHNs), as frontline health professionals embedded in the community, are able to translate and communicate health information including environmental health risks to communities. This is an especially important PH nursing role for UOGD communities. Residents must have an accurate understanding of their health risks so that they can make informed decisions regarding signing gas or oil leases, testing of drinking water, relating health symptoms to possible exposures, communicating with health providers, and addressing the specific vulnerabilities within their households, such as a pregnant family member. They also must understand their exposure risks so they are able to provide accurate health histories. The participants voicing their concern of environmental exposures potentially harming their children and future generations supported this. Strong bonds to the land and community, as described by the participants, make experiences of a changing community particularly stressful. Understanding the environmental impact could increase community members' engagement (Friedman et al., 2014) and enable community members to advocate for health-protective regulations, which could help reduce feelings of powerlessness.

It is a primary PHN role to educate communities regarding environmental health risks and

actions to reduce risk. To adequately educate community members PHNs must be certain that they have accurate and up-to-date knowledge regarding those risks. Given that a participant reported inaccuracies from a physician regarding the health impacts of silica exposure, health information regarding UOGD should be directed to health professionals as well as community members. PHNs are positioned to provide reliable, accurate, evidence-based information and share that information with other colleagues and the public. It is also essential that PHNs teach UOGD communities methods to monitor their environmental health risk such as water testing and stress, and methods to reduce risk such as stress management and when possible, removing oneself from an area with elevated air pollution. As determined from this study there was a preference for online information with downloadable printable materials to share UOGD environmental health information.

Community advocacy is another critical PHN role and PHNs are ideally positioned to partner with UOGD communities to advocate for health-protective policies. A community-based participatory approach of exchanging information and developing community advocacy strategies could enhance efforts and promote community health (Friedman et al., 2014). To support effective community advocacy and diminish feelings of powerlessness, community activists could benefit from partnering with PHNs and environmental advocacy organizations for advocacy training to facilitate creation and dissemination of targeted messages. In this study, community activists' efforts were largely done at the local level, although the policies that address UOGD are primarily made on the national and state levels. In addition, to articulate the needs of UOGD communities, PHNs should seek their place at the policy-making table to be sure UOGD environmental health impacts are considered (Goldstein et al., 2012). Environmental health education and advocacy should include air quality monitoring and regulations that protect drinking water and community mental health related to powerlessness and stress.

There are limitations to this study. First, the participants do not represent all of Wyoming County as this group had a higher education and income than the county average and no participants in the study had an UOG well on their property. Secondly, only 5 of the 27 participants verified the study findings. The participants self-selected to participate because of concern about the health issues, and these may not be the same concerns of other residents in Wyoming County or other UOGD communities.

This is one of the first studies in the region to address community's health concerns related to UOGD. This study found that some community members sought out knowledge and were engaged in issues that influenced the health of their communities. Recommendations for future research include examining the overall health impacts of powerlessness and stress on UOGD communities and gathering the evidence of effective programs that reduce environmental health risks and feelings of powerlessness and stress in UOGD communities.

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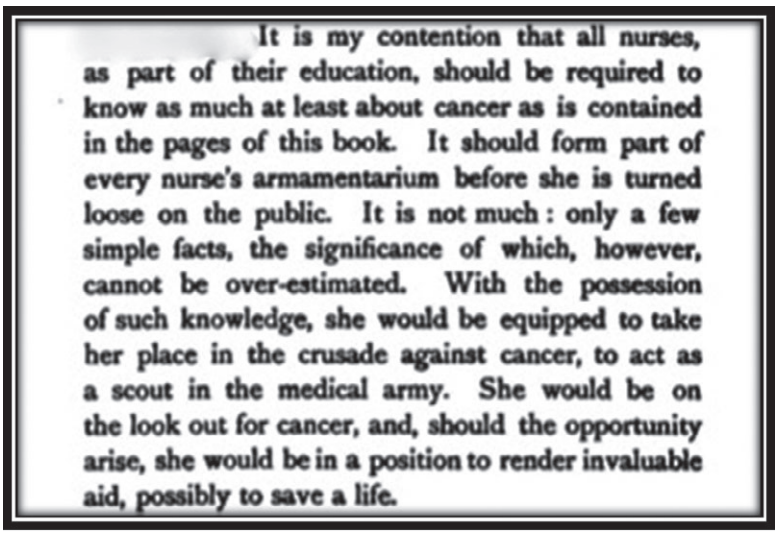
It is my contention that all nurses, as part of their education, should be required to know as much at least about cancer as is contained in the pages of this book. It should form part of every nurse's armamentarium before she is turned loose on the public. It is not much: only a few simple facts, the significance of which, however, cannot be over-estimated. With the possession of such knowledge, she would be equipped to take her place in the crusade against cancer, to act as a scout in the medical army. She would be on the look out for cancer, and, should the opportunity arise, she would be in a position to render invaluable aid, possibly to save a life.