

Chronic Kidney Disease Undetermined (CKDu) in Nicaraguan Sugar Cane Workers: Legal, Medical, and Ethical Analysis-A 5 Year Update

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Abstract

Chronic kidney disease of unknown origins (CKDu) is now the second-leading cause of death in Nicaragua, and number one leading cause of hospitalization in Central America. [1] The pressure to find a cause to this growing epidemic has increased because as many as 40,000 people in Central America and Sri Lanka have died from CKD in the past 10 years. [2] It affects many plantation workers in the tropical regions, but this paper will focus on sugar cane workers in Nicaragua in an effort to increase awareness and to continue pressuring sugar cane companies into reforming their workplace policies. Many aspects of CKDu will be analyzed including a legal analysis of different aspects of sugar cane companies' role in the sugar cane industry and labor rights of sugar cane workers, a medical analysis of the effects of dehydration on kidneys and prevention methods in developing countries, and an ethical analysis of the companies and Nicaraguan government's role in the CKD epidemic. The methods used in this Heracles analysis include journals, articles and research studies and first-hand communication with Jason Glaser, Co-Founder and CEO of La Isla Network.

INTRODUCTION

Chronic kidney disease of unknown origins (CKDu) has killed about 40,000 individuals alone in the last 10 years in Mesoamerica and Sri Lanka. This does not account for other affected regions and unreported cases of CKD. [3] These numbers are especially shocking because CKD in developed countries has treatment plans that, if followed correctly, do not lead to death. The treatments in developing countries, such as Nicaragua, are not able to support the number of individuals effected by CKDu. Until a cause can be pinpointed, the death toll will keep increasing.

The cause is difficult to determine due to the fact that it is thought that multiple factors play a role, companies are wary and resistant to CKDu research, and widely unavailable treatments. Currently, many research facilities studying CKDu in Central America are pointing to heat stress and work-intensity as a major reason why the rate of CKD in sugar cane workers is extremely high.

Within the sugar cane industry, there are different jobs for

field workers: cane cutters, seed cutters, repair workers, and field support are a few examples. Cane cutters were determined to have the most demanding sugar cane field work. It is predicted that the amount of work a cane cutter completed in a day is compared to running an ultra-marathon 6 days a week. [4] This type of work is done in 40 degrees Celsius heat for almost 12 hours a day.

Some researchers believe that although these tropical areas experiencing high rates of CKDu have high temperatures, there have been recent increases in temperature that might help provide an explanation as to why CKDu continues to occur. Dr. Sorensen, an emergency medicine physician and professor at the University of Colorado School of Medicine, believes that kidney disease could be the first disease to be identified that has a direct association with extreme global temperatures [5]. The recent rise in temperatures of places effected by CKDu may be an indirect consequence of climate change. [6]

Glyphosate and other pesticides were part of the original idea as to why many sugar cane workers in Nicaragua are

developing acute kidney injuries that lead to CKD. Even though glyphosate's role as the cause of CKD is no longer a main focus, it should not be completely disregarded as a harmless chemical.

Monsanto introduced glyphosate in 1974 as a commercial pesticide. [7] Its popularity began in the 1990s, and has since become a widely used pesticide all over the world. Roundup made Monsanto the largest seed company in the world.

The effects of glyphosate are wildly researched. It is commonly debated if glyphosate is a cancer-causing substance or not. The International Agency for Research on Cancer conducted a study in March 2015. They concluded that glyphosate is most likely carcinogenic. They used data that was public knowledge. [8]

Monsanto began funding research based on its product. Due to the agro-giant paying for research, the data is kept private. However, the conclusions are public, and the final word from Monsanto's researchers was that glyphosate is not carcinogenic. [9] This poses a conflict of interest concerning Monsanto and its pesticide products.

Boston University has been conducting ongoing research regarding glyphosate and its role in CKDu and cancer. Their data suggests that CKDu is more likely to be caused by dehydration and extreme heat than glyphosate and pesticides. [10] Even though many of these theories have had minor successes in influencing sugar companies, there is not one theory accepted enough to be concluded as the official cause of CKD in sugarcane workers.

The researchers at Saint Joseph's University in Philadelphia, continue to argue that CKDu is a combination of extreme heat (possibly due to climate change), dehydration, and glyphosate. The reasoning behind this theory will be analyzed in a legal, medical, and ethical section.

When a cause is determined, one must also consider treatment and its availability. Nicaragua, and many of the other countries affected by CKDu, are poor and developing. The estimated U.S. average of billed charges per kidney transplant in 2017 was \$414,800. This includes costs such as hospital admission, procurement, and immunosuppressants. [11] An agricultural worker has to be paid at least 3,187.43 Córdobas a month (265.60 USD). [12] There needs to be more affordable and accessible options for Nicaraguan sugar cane workers.

It is important to remember that although treatment is important, we must also focus on prevention. This can only be done if awareness is increased to pressure sugar companies and the Nicaraguan government to change workplace policies and protect their workers. Nicaragua needs the continued external and internal pressure to make the proper changes, which is why this article will focus on Nicaragua particularly. This article will examine the legal issues of the sugarcane industry, the medical concerns of dehydration and kidney injury, an ethical evaluation of concerns surrounding CKDu, and propose recommendations on how to prevent CKDu in Nicaraguan sugarcane workers. CKDu will be analyzed in a way that calls for changes and advocates for the rights of the sugar cane workers.

LEGAL ANALYSIS

The reasons for lack of care and support for those suffering from CKD can be analyzed by looking at the legalities of this epidemic. Legalities include labor unions and rights, positions of the Food and Drug Administration and Environmental Protection Agency, lawsuits and international bans on glyphosate.

In Nicaragua, forming a trade union is not as easy, or as common, as it is in the United States. The ability to legally unionize returned to Nicaragua in 2007 when the Sandinistas, the socialist political party, returned to power. [13] When workers began to unionize, management of the sugar plantations would use intimidation factors to try and prevent workers from joining together. Currently, there is a trade union called the National Worker's Front that includes smaller sectors for educators, health workers, sea and coastal workers, and agroindustry workers. The agroindustry-specific trade union is known as The National Confederation of Agroindustry Workers. [14] However, none of the field workers on the sugar plantations specifically are unionized. Union leadership becomes corrupt due to their own self-interest, so workers decide to stay independent and hope that the corporate administration protects them. [15]

Although it's uncommon to form a trade union in Nicaragua, there are organizations that help sugar cane workers file formal complaints against their employers. The workers want to see improvements in their work environment and their medical benefits. La Asociación Chichigalpa por la Vida (ASOCHIVIDA) is an organized group of over 2,000 former sugar cane workers who suffer from CKD. [16] ASOCHIVIDA and 673 local residents of Chinandega,

Nicaragua, filed a complaint in March 2008 to the Center of International Environmental Law (CIEL) against Nicaragua Sugar Estates Limited (NSEL) with the help of the Compliance Advisor Ombudsman (CAO). [17] NSEL owns a sugar cane complex in Chinandega called Ingenio San Antonio.

By filing this complaint, ASOCHIVIDA was able to come to an agreement with the Nicaraguan government and NSEL in 2012. [18] ASOCHIVIDA secured provisions such as improving the medical care and medical facilities for CKD-affected workers, addition of income-generation projects for the affected worker's family, and ongoing research by Boston University to look into the causes of this epidemic. [19]

Another organization that has been aiding in the fight to find a cause to CKD is La Isla Network. With the help of Adelante Initiative, they are currently in Nicaragua strictly for research, instead of doing community work.

Adelante Initiative is a data collecting organization that is working with La Isla Network to study field workers, especially seed and cane cutters, and the responsibilities of Ingenio San Antonio, a large sugar cane company in Nicaragua [20]. Their efforts are focusing on heat stress and work intensity as the main cause of CKD in sugar cane workers. It is understood, however, that CKD in Nicaraguan sugar cane workers is multi-factorial. [21]

It is estimated that cane cutters, the most difficult job for sugar plantation workers, move approximately five to six tons of sugar per work day [22]. Cane cutters are paid based on how much sugar cane they bring in by the end of the work day, which increases the pressure to complete more and exert more effort. It is reported, that cane cutters work in temperatures up to 40 degrees Celsius for 12 hours per day, causing them to lose about 2-3 pounds of fluid per day. [23] The work of a sugar cane cutter is comparable to running an ultra-marathon six days a week. [24]

It is the responsibility of sugar cane companies, such as Ingenio San Antonio, to take responsibility and provide more protections to their workers. The International Labour Organization (ILO) states in their document establishing hours of work that "The working hours of persons employed in any public or private industrial undertaking or in any branch thereof... shall not exceed eight in the day and forty-eight in the week (with few exceptions)." [25] The hours that sugar cane workers are currently putting in are not

being held to these standards.

As more cases of CKD and other health-related issues arise, more countries and consumers are beginning to consider how glyphosate is playing a role. Countries, such as France, have banned the use of glyphosate. The agro-industry giant, Bayer AG, is facing many lawsuits that are naming RoundUp, a pesticide containing the active ingredient glyphosate, as a carcinogenic substance. However, the Food and Drug Association (FDA) and Environmental Protection Agency (EPA) do not consider glyphosate as a risk to human health. The EPA claims that glyphosate has a low toxicity in humans. They have data suggesting that glyphosate poses risks to mammals for chronic or long-term exposure. The organization has so far used 67 studies to review the potential uses in a human health risk assessment. However, a majority of the literature studies were found to be unacceptable. They did not meet criteria needed to properly analyze use of glyphosate on human health. [26]

MEDICAL ANALYSIS

Impact Hypovolemia and Dehydration Has on the Pathophysiology of the Kidneys:

As the rates of CKDu remain high in these developing countries, interventions will need to be placed to decrease the incidence of this idiopathic disease. It is widely known that hypovolemia can have a major role in kidney dysfunction therefore adequate hydration is vital especially when working strenuous jobs in arid working environments. Additionally, environmental factors such as elevated temperatures and lack of access to clean drinking water in these areas only exacerbate the risk of developing kidney damage. The hypovolemia which can result in these workers can lead to decreased blood flow to the kidneys which in turn can lead to pre-renal azotemia. Pre-renal azotemia is characterized by a decreased perfusion of blood to the kidneys leading to a decreased glomerular filtration rate (GFR). The patient is often asymptomatic initially and may not seek medical attention. Clinically this will present as an increased BUN and creatinine levels along with decreased GFR. If treatment measures such as volume resuscitation, avoidance of causative factors, management of high blood pressure or diabetes aren't initiated during the early stages of the disease, further damage can lead to acute tubular necrosis of the kidneys. The hazardous working environments these workers are in can lead to severe dehydration putting them at risk for ischemia of various vital organs including but not limited to the kidneys. Prolonged ischemia of the kidneys

will eventually lead to acute tubular necrosis as the cells of the renal tubule die off. As these tubular cells necrose, they eventually slough off into the tubular lumen and cause obstruction.

If this damage is allowed to persist without early treatment this can proceed to the development of permanent kidney damage in the form of chronic kidney disease (CKD). CKD is a significant disease which increases the risk of morbidity and mortality of all patient diagnosed with the disease. The risk of cardiovascular events, stroke and possible need to be placed on hemodialysis are all significantly increased compared to the population of those who do not have CKD. Specifically, the rates of all-cause mortality are higher in younger individuals with CKD compared to elderly patients with the same disease. Furthermore, there is a risk especially in these young workers of muscle break down leading to rhabdomyolysis which is another significant factor leading to kidney dysfunction. Another potentially unidentified risk factor for development of kidney damage may be the chemicals these workers are exposed to in the fields in order to perform the functions of their jobs. Further investigation would be warranted in order to determine if there are potential nephrotoxins leading to kidney dysfunction.

Primary Prevention Methods:

Due to the significant impact blood volume has on the kidneys, it is of utmost importance that the workers are properly hydrated on a regular basis and take precautions to avoid dehydration. Many of these workers may be losing large volumes of fluid including key electrolytes due to the extreme heat and hard labor. For this reason, adequate hydration remains a top priority for these workers in order to prevent hypovolemia which can lead to decreased perfusion to the kidneys and eventually damage. Water along with other fluid sources that include electrolytes will need to be regularly provided to these workers. Implementing primary prevention techniques should be a top priority in Nicaragua to decrease the incidence of this CKDu. Primary prevention methods will also decrease the burden on the society leading less people to progress to CKD and eventually decreasing overall health care costs overall. Primary prevention methods include regularly scheduled healthcare visits with follow-ups as recommended by the primary care provider or nephrologists. Regular scheduled visits will allow the physician to identify risk factors before they lead to functional kidney damage. Chronic kidney disease can be a preventable disease if the risk factors such as diabetes,

hypertension, smoking, dehydration and obesity can be controlled. Safe working environment is also a method of primary prevention that could have significant impact in the long term. A safe work environment includes accounting for the high temperatures, frequent breaks and reducing the amount of chemicals that the workers are exposed. Furthermore, it is of utmost importance that the healthcare workers are able to identify signs of dehydration as their bodies begin to compensate for the lack of water consumption. Many signs of dehydration are non-specific symptoms such as weakness, fatigue, muscle cramps, and hypotension. Muscle cramps and muscle twitching can be attributed to the electrolyte imbalance that occurs during severe dehydration. As the lack of hydration progresses, it can eventually lead to severe organ damage due to the ischemic state caused by the low perfusion pressure. Additionally, it is also vital that the workers understand the signs of heat exhaustion as well. Heat exhaustion can often present with non-specific symptoms as well such as dizziness, confusion, nausea, vomiting, dark-colored urine. The color of urine is a critical marker for hydration levels and during dangerous dehydration urine will turn dark yellow as your kidneys are attempting to conserve water for the body. Even more importantly, if the urine starts turning dark brown (“cola-colored urine”) then it could be a sign that the muscles in a person are undergoing rhabdomyolysis (muscle breakdown) and its waste products are ending up in the urine. Rhabdomyolysis is a life-threatening condition that is usually treated with IV fluids and if severe enough dialysis may be needed. It is of the utmost importance that the patients are taught to recognize these dehydration and heat exhaustion symptoms so that actions can be taken before the damage to the kidneys progresses to CKD.

ETHICAL ANALYSIS

CKDu is a “silent killer.” The early signs of this disease, jaundice and fatigue, usually go unnoticed, because the sugarcane workers are not well-educated and are desperate to provide for their families financially. Once the disease advances to its later stages CKDu’s treatments, dialysis or kidney transplants, are far too costly for sugarcane workers in Central America. However, the prevalence of CKDu is highest in these sugar producing communities. CKDu has become the leading cause of death among men in Central America. Since 2004, 46% of male deaths in Chichigalpa, Nicaragua-the country with the highest CKDu death rate in Latin America- were caused by CKDu. In the area of Chichigalpa now called “La Isla de Viudas” (the Island of

Widows) 7 in 10 men have CKDu. To date, over 20,000 deaths in Central America has been linked to CKDu. [27]The sugarcane industry in Nicaragua has quadrupled in size to a \$500 million a year industry, yet at what cost? Young men are dying by the thousands from CKDu and nothing substantive is being done to stop these deaths. One could speculate that profit is driving the industry. Why would the sugar cane industry invest time and money dealing with CKDu when there are many more workers available in Nicaragua to replace the ones that die? Profitability of the sugarcane industry is a priority for the Nicaraguan government and business community. The cause of CKDu needs to be determined now and new procedures need to be put in place to stop the growing death rate from CKDu. This is an imperative because the demand for sugar worldwide is increasing, which will cause an unmonitored expansion of the industry. Ethically, allowing profits from an industry to increase at the expense of the lives of the poor and most vulnerable members of society violates every principle of ethics. It will be argued that—according to the ethical principles of respect for persons, beneficence/nonmaleficence, and justice—action must be taken immediately to address the concerns surrounding the cause of CKDu. Such actions will not only save lives, but will also do much to conquer the mistrust that now exists between the people of Nicaragua and their government and business leaders.

“Respect for persons” refers to the right of a person to exercise self-determination and to be treated with dignity and respect. The principle of respect for persons divides into two separate moral requirements: the requirement to acknowledge autonomy and the requirement to protect those with diminished autonomy. [28]Numerous abuses of sugar cane workers have been documented in Nicaragua such as: long working days and weeks, inhumane working conditions, inadequate protection from pesticides, unjust salaries, etc. Many of these workers are only hired during the harvest season so they must earn their living for an entire year in just six months’ time. [29] These abuses should be abhorrent to anyone. But for medical personnel who care for these workers in the camps, who should have been trained in human rights and ethical principles, these abuses should have been reported and stopped. To witness or to have known about any of these abuses and not to have reported them or tried to stop them is a direct violation of the principle of respect for persons. Every ethical document from the Hippocratic Oath to the U. N. Universal

Declaration of Human Rights clearly state that, “no human person should be subjected to torture or to cruel, inhumane or degrading treatment or punishment.” [30] To highlight the point that these workers are not being treated with dignity and respect, sugar cane companies are under pressure to minimize growing/processing time in order to increase output. The chemicals used to increase output are having serious medical consequences for the sugar cane workers including acute kidney injury. In addition, the burning of the fields at the end of the growing season leaves a scorched earth, killing native plants and causing harm to children, pregnant women and even the livestock. During the harvest season the temperatures are extremely high and there is no trace of water or shade available to the workers. Even prescribed rest periods seem to be non-existent. The sugar cane companies are not providing humane working conditions or practices to protect these vulnerable workers from illness and even death. Company medical personnel allegedly are aware of these conditions and treat the workers for dehydration, kidney injury, urinary tract infections, heat stroke, etc. but then send them back out into the fields. Not to report such action as cruel, inhumane and degrading treatment defies comprehension medically, legally, ethically and from a humanitarian perspective.

Second, sugar cane workers are truly vulnerable persons with diminished autonomy and deserve added protection. They are at the mercy of their employers and have no protections provided by the government of Nicaragua. Critics of those in the medical profession who medically treat these workers argue that the physician-patient relationship is the primary focus of ethics in medicine. Trust is the bridge to the physician-patient relationship, and the burden is on the physician not only to expect the patient’s trust but also to build a solid foundation upon which the patient can place his or her trust. [31] If this relationship becomes fractured, a loss of confidence will result, and the effect on the patient could be devastating. For sugar cane workers to see their primary care physicians or the physicians supplied for the sugar cane companies not giving adequate medical care or remaining silent in the face of such human rights violations undermines the credibility of the medical profession and is irreconcilable with the physician’s role as healer. There also seems to be a conflict of interest present between preserving the primary fiduciary relationship between physician and patient and the responsibility of an employee to an employer. There is a definite conflict or “dual loyalty” between the physician’s

duty to his/her patient and the medical professional's duty to his/her employer. Participation in the blatant breaches of patient autonomy not only violates the fiduciary relationship between physician and patient but shows a clear conflict between a physician who serves the interests of the company and not those of his/her patient. This violation of respect for persons may also prevent some workers from seeking needed medical care because of the lack of trust they now have for their physician. A basic tenet of the principle of respect for persons is that one must never use another person as a means to an end. Opponents argue the sugar cane workers are being used as means to an end in an attempt to maximize outputs and achieve the company's quotas. Human rights and the basic dignity and respect that every person deserves become the casualty.

The failure of company physicians, company executives, and governmental agencies to be proactive in addressing the medical needs of this most vulnerable population in regards to CKDu is causing needless suffering and death. These workers have no choice but to work in the sugar cane fields because it is the only work available to them. It is a matter of survival. The cause of CKDu must be determined now and new policies must be initiated to protect this vulnerable population. To deny the sugar cane workers safe working conditions and proper medical care clearly violates the ethical principle of respect for persons.

The principle of beneficence involves the obligation to prevent, remove, or minimize harm and risk to others and to promote and enhance their good. Beneficence includes nonmaleficence, which prohibits the infliction of harm, injury, or death upon others. In medical ethics this principle has been closely associated with the maxim *primum non nocere* ("Above all, do no harm"). Sugar cane workers and the people of Nicaragua have the right to know what is causing the death of 20,000 men and women who work in the sugar cane fields. This enigmatic kidney disease is a silent killer affecting agricultural workers and others in Central America. Family members and sugar cane workers argue that the government of Nicaragua is corrupt and in collusion with private industry to promote profit. The government argues that it is doing everything possible to promote and enhance the good of the sugar cane workers. The problem is that this is a contradiction because the cause of CKDu still remains a mystery.

Researchers are investigating the various causes for CKDu but the epidemic continues. Clearly there is a link between

heat stress, dehydration, working conditions and pesticides. The sugar cane industry and the Nicaraguan government argue that they have instituted new policies to keep the workers safe and alive. Industry executives stipulate that there are mobile clinics equipped with a cooling area that takes blood and urine samples and offers hydrating beverages and food for workers in the fields. They also claim that they pay workers for a seventh day of rest. Opponents argue that there are not enough medical supplies and hydration packets for the number of workers in the fields. They also argue that the mobile clinics only screen workers that are not sick, and then whenever there are visitors to the fields, more provisions are provided. [32] Even if the intentions of the government and sugar cane industry are good, the unjust working conditions and use of pesticides in the fields is a violation of nonmaleficence.

There is clear evidence from studies over the past 50 years that there has been a negative impact of pesticide use in Nicaragua. There has been underreporting of acute pesticide health effects, but since the 1980s this evidence has become clear. Studies have concluded that pesticide use in Nicaragua is causing acute and chronic effects and that there is a high acute pesticide poisoning incidence rate in the general population. [33] Glyphosate is causing direct harm to the sugar cane workers. Glyphosate attacks the kidney tubule. It binds to the heavy metals, and that compound lasts in the body for a very long time—with over a 20-year half-life—thus the first word in the epidemic disease chronic kidney failure. Since glyphosate can be inhaled, ingested, or absorbed through the skin, farmers and sugar cane workers are especially at risk of being exposed. Furthermore, the human liver, which is normally responsible for eliminating heavy metals and other toxins from the body, cannot detect glyphosate, so it bypasses this important purification step, and goes straight into the kidney tubules. The glyphosate and heavy metals then attack the kidneys, causing severe disease. [34] In addition, due to the poor working conditions and frequent dehydration of the workers, company physicians and pharmacists in Nicaragua are prescribing medications such as diuretics, antibiotics and NSAIDs for symptoms that may be related to dehydration and volume depletion. These factors, alone or in combination, may be possible contributors to kidney damage. Researchers are highly recommending that acute kidney damage coupled with volume depletion and exposures including medications and infectious agents should be further evaluated as causal factors for CKDu in Nicaragua. [35] There is a need to do

what is in the best interest of these sugar cane workers. Twenty thousand innocent lives have been lost and more will die unless we maximize benefits and minimize harms—ban the use of glyphosate and other pesticides. This can only be done by funding further research in this area, instituting government regulations on working conditions, and banning glyphosate use in the sugar cane fields. Failure to recognize this great need is a failure not only of the test of beneficence; it may also be a failure of the test of nonmaleficence.

The principle of justice recognizes that each person should be treated fairly and equitably, and be given his or her due. The principle of justice can be applied to the circumstances of “dual loyalty” when sugar company physicians must choose between responsibility for their patients in need of medical care and the demands placed upon them by executives of the sugar cane industry. The most common rationale for medical professionals’ willingness to participate in or overlook the various incidents of abuse is their sense of duty to their employer. When company physicians are called upon to treat sugar cane workers for symptoms of CKDu many believe they are acting in the best interests of the workers, the nation and humanity. The argument is that the medical professionals have a moral duty to ensure that medical care for the workers is carried out in the most fair and humane way possible. They argue that they are treating these workers with the best medications available. Opponents argue that these physicians violate the basic tenets of human rights law and the ethical standards of the medical profession. It may be true that the physician’s participation is offering some degree of humanness to the situation because they are seeing and treating these workers. However, they are ignoring symptoms at times, sending workers back into the fields to further damage their kidneys, knowing full well, none of these workers if they have CKDu could ever afford dialysis. Is this treating someone fairly and equitably? These physicians must know that CKDu is an epidemic. They must know the symptoms of CKDu. They must know that the working conditions are unjust and harmful to the workers. They must know or at least suspect that glyphosate is a major issue regarding CKDu. Finally, they must suspect that the medications they are prescribing will not help these workers in the long-run. Every medical professional has the right, with a well-formed conscience, to refuse any order that he/she believes is unjustified and personally unethical. Every medical professional has the duty to report conditions he/she

believes could be the cause of this mysterious epidemic. The failure of medical professionals to recognize that their duty as an employee of a particular company can never trump medical ethical principles is clearly an injustice. It is an injustice not only to those who were abused but to humanity as a whole. If the principle of justice mandates that each person should be treated fairly and equitably, then the participation of medical professionals in cruel, inhumane and degrading treatment of workers clearly violates the principle of justice.

We Americans espouse the belief that all men and women are created equal. Equality has also been a basic principle of the medical profession. If we truly believe in equality, we should insist that all men, women and children receive equal medical treatment and resources. Denying knowledge of medical treatment to individuals suffering from CKDu, treating such workers and then sending them back into the fields where they will be further compromised without due warning, violates a basic tenet of justice. Physicians and clinical researchers have an ethical obligation to draw attention to this mysterious disease. However, as a matter of justice, it is not only these professionals who have an ethical obligation to inform the world about this epidemic. It is the responsibility of all wealthy nations and international developmental agencies to solve this medical mystery. Not because it is solely in the best interest of the sugar cane workers in Nicaragua, but because Central America exports a large amount of raw sugar to developed nations. The raw sugar, because of pesticide use, could have adverse effects on others as well. Failure to find the causes of CKDu is ethically irresponsible and morally objectionable. To compromise the basic ethical foundations upon which medicine stands is destructive not just for the sugar cane workers of Nicaragua but for humanity as a whole.

To address these medical, environmental and ethical concerns, we propose various recommendations to address CKDu now and in the future. Unless the world community addresses these needs for additional education and proposes new policies we will never attain the goal of eradication of CKDu. We hope our recommendations will not only save valuable medical resources; but have the potential to save precious human lives. If we do not make this a priority now, everyone will pay a price in the future.

RECOMMENDATIONS

1. The United Nations should ban glyphosate in

Central America and in the world as a pesticide. The potential links between glyphosate and CKDu are enough to prove the toxicity of the chemical. Continuing to use it at the industrial and commercial level is endangering too many people. The glyphosate ban should follow set by France. By banning glyphosate, a potentially deadly risk is being eliminated.

2. Safer workplaces should be provided through the implementation of hydration, rest and shade policies, hydration backpacks like CamelBak®, shortened work hours, and proper medical care. Workers should also be given access to better pesticide training and effective protective gear before each harvest and an age requirement should be established for handling pesticides. An example of an effective policy would be the policies initiated by El Salvador that ensure worker safety. At the sugar cane mill Ingenio El Angel, at least 65 workers were given rest, water, and shade throughout the harvest. As a result, since the start of the program, kidney functions have stabilized and heatstroke has been eliminated. [36] If these programs were to be brought to Nicaragua along with an effort to reduce pesticide poisonings, then the number of CKDu patients and deaths could decrease.
3. Sugar cane fields must be a minimum of 300 meters away from any houses. While talking to sugar cane workers and their family members, we learned that some people not working in the fields also developed CKDu. If the houses are close enough to the field then pesticide spray could be carried by the wind and breathed in by families not working in the field. There is also a risk of chemicals entering the local water supply via runoff or spills. By moving houses further away from the sugar cane fields, then the risk of non-workers developing CKDu is eliminated.
4. Nicaragua and other agricultural countries should use an acetic acid solution as an alternative to glyphosate. The University of Maryland conducted a study where they tested vinegar as an herbicide as opposed to glyphosate. They found that using acetic acid has a rapid kill rate and it breaks down quickly in its surrounding environment. [37]
5. The World Health Organization and other international medical organizations should supply more funding for research on glyphosate and CKDu. Both topics are constantly debated with no universal and accepted agreements. Until there is a set causal definition of CKDu and glyphosate's role as a carcinogen and in CKDu, sugar cane companies will keep policies the same. This will then keep the CKDu rate increasing. Funding should also be increased for kidney treatments in Nicaragua to treat CKDu until there's ample funding to prevent CKDu.
6. The Nicaraguan government should be held more accountable for ensuring that companies, especially sugar companies, are held accountable of their workers. The structure of the work should follow the guidelines in place by the International Labour Organization.
7. The Nicaraguan government must provide water filtration systems for the affected areas. As stated above, the families that we spoke to in Nicaragua explained how non-workers who lived near the sugarcane fields still developed CKDu. One of the possible causes is water contamination from pesticide usage on the sugar cane. Water testing and water filtration systems would provide safe drinking water for the workers and their families.
8. The Nicaraguan government must immediately enact the 2016 Paris Agreement on Climate Change recommendations to lower the world temperatures. Climate change has seriously affected the sugar cane workers in Nicaragua. The higher temperatures increase the worker's risk of getting heatstroke and dehydration. The goal of the Paris Agreement is to reduce global average temperature to well below 2°C by the year 2020. [38]
9. Health care workers, ethicists, human rights advocates, etc. should continue to raise awareness of the CKDu epidemic. This will again increase pressure on the Nicaraguan and sugarcane companies to change the policies already in place that are not preventing CKDu.
10. The Environmental Protection Agency and Food and Drug Administration needs to be more open to limiting the distribution glyphosate. The EPA has recently refused to ban chlorpyrifos, a pesticide that kills insects, that has been linked to negatively affecting childhood neurological development. [38] They need to be pressured to take into consideration human life and the effects pesticides have on life.
11. The Nicaraguan Ministry of Health must provide better education for physicians and other health care workers on the effects of dehydration and pesticides on a worker's kidneys and liver. A physician's job is to treat and ensure the health of his/her patients. In some cases, the sugar cane workers are either misdiagnosed or given an incorrect treatment for their disease. These incorrect treatments can worsen the effects of CKDu. If physicians were specially trained to treat patients with CKDu, then many workers would receive the proper care. Training could include an overview of what medications are allowed for CKDu patients as well as ways to avoid further injury to the kidneys. Many of these workers have limited knowledge about CKDu and how to protect themselves from injury. Physicians have the professional and ethical responsibility to help them understand their disease and to better their health. This can be done with additional training and education for the physicians.

CONCLUSION

The cause of CKDu is not only multi-factorial, but the epidemic as a whole is as well. This paper analyzed the epidemic from a legal, medical, and ethical standpoint. Too many lives have been lost, and too many families have been broken due to not focusing on this global issue. Through a comprehensive literature review, the causes can be determined to be a combination of extreme heat, work intensity, dehydration, and glyphosate. This paper demonstrates that CKDu cannot be approached solely as a

medical issue, but as a legal and ethical issue as well.

Increasing temperatures is increasing rates of CKDu, not just in Nicaragua. Poor treatment facilities and lack of accessibility to these treatments is preventing those affected by CKDu from proper medical care. Dehydration due to poor working conditions and little to no breaks is increasing the risk of kidney injury which can lead to CKDu. It is time that international leaders and organizations stand up for those affected by CKDu to prevent anymore loss of life.

These workers are not just a means to an end. Sugar cane workers are worth more than the product being cultivated. It is time to show them that their lives are worth saving.

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