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For the students, by the students



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# Acknowledgements



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## **Analyzing the Factors, Problem Behaviors, and Appropriate Interventions in Human Trafficking/Trafficking in Persons**

*Emily Madsen, Psychology '12*

### **Facts and Definitions**

Today there exists an excess of 30 million slaves in our world, which are covered under the topic of trafficking in persons (TIP) (Batstone, 2010). Just as it is important to operationally define any behavior that requires a treatment or modification, TIP must be classified to warrant the most effective interventions. Despite its longstanding history, many countries still fail to possess an official definition of TIP. The United Nations classifies human trafficking as recruiting and concealing persons for the purpose of exploitation through force, deception, and abuse, while exchanging money for these services where one person exerts control over another more vulnerable individual (Aronowitz, 2009). It is estimated that approximately two and a half million people are being trafficked at any point in time (Chuang, 2006). The issue is increasingly difficult to detect since TIP is a hidden industry due to its illegality and risks. While the focus is most often placed on sexual exploitation (accounting for 46% of TIP), the division of forced labor includes domestic service, sweatshop/factory work, and restaurant or hotel work (Batstone, 2010). The subsequent evaluation will discuss behaviors encompassed in the process of TIP, profiles of those involved in the industry, and functions that the individual behaviors serve. In the end, possible interventions to improve and attempt to solve the immense issue will be examined.

### **The Process**

The industry of TIP can be viewed as a process (Aronowitz, 2009; Hughes, 2004). First and foremost there is a vast demand for women to be used. Next in the process pimps place orders to receive the women they desire for their brothel or business. An important and often overlooked component comes into play, which is the corruption of authority. The government and/or police often accept bribes or ignore the ongoing acts of TIP (this corruption is often prevalent in the transport stage). The victims are then coaxed and abducted as they are recruited into an industry that is challenging to break free from, often transported across borders. The step that follows is the continuous abuse and exploitation of the victims within the system.

### **Victim Profile**

To understand how to best change the motion of this issue it is vital to establish the profiles of the individuals involved and factors that lead to their involvement. The victims, primarily prostitutes and sexually enslaved women, often end up in the industry due to factors such as poverty, unemployment, and lack of opportunities, but these are not the cause of trafficking, rather criminals are taking advantage of these variables (Hughes, 2004). Risk factors for these victims can penetrate to their cultural values and traditional practices for their country or region. In many parts of the world girls possess less value than boys, and in some countries the demand for young girls is powered by the misconception, yet widely accepted idea that having sexual intercourse with a virgin can act as a remedy for HIV/AIDS (Aronowitz, 2009). A person's upbringing contains many factors to which may put them at a risk to being involved in

TIP, including the background of a traumatic childhood (physical, sexual, and emotional abuse) and low socioeconomic status (where being raised by an impoverished family can lead to later being bought from or abandoned by the family for the family's ease and benefit). Many of these dimensions function as setting events. A setting event serves as the context that affects the rest of the behavioral contingency (antecedent, behavior, consequence). Setting events can impact this contingency by altering the strength of the antecedent-behavior relationship, impacting the signaling of a response. Additionally setting events can also impact the power of the consequence in reinforcing or punishing a response. In essence, setting events are broader environmental events or conditions that influence relationships within a contingency (Novak & Pelaez, 2004). A person's gender and age also put individuals at a greater risk for being victimized, therefore being young and a girl act as setting events – meaning that being of this demographic triggers, or makes the occurrence more likely to ensue. Reports by the FBI conclude that while victims can be found as young as nine years of age, the average age of a child first brought into the industry hovers around 11-14 years old (Bales & Soodalter, 2009). The vulnerability and gullibility of this age is alarming, as they become a group easily coaxed by the persuasion of culprits. Furthermore, children are at higher risk of becoming victimized because there is an elevated charge for having sex with minors, which in turn provides the traffickers and pimps with a higher profit (Busch-Armendariz, Nsonwu, & Cook Heffron, 2006). The female gender is the targeted sex due to again, the increased vulnerability of women and girls, as well as males being the predominant sex in demand of the services. Additional at risk groups include estranged, runaway, or outcast children (Cullen-DuPont, 2009), the physically and mentally impaired, the homeless, and those struggling with drug addiction (Aronowitz, 2009). These conditions can be seen to function as setting events for the individuals' vulnerability. All of these groups are less capable of defending and protecting themselves when it comes to the persuasion of the traffickers.

Pull factors also exist, which seemingly attract the victim to the claims made by traffickers who offer the possibility of a better life. The enticing offers made by the recruiters attract those victims who have fear of abandonment or no feelings of value in their current situation, so they follow the pimp who provides love, comfort, and a sense of need for the girl. It is increasingly clear that pimps will manipulate and essentially brainwash their victims into believing what they have within the confines of the brothel is better than what the outside world offers. Emotional coercion and manipulation to make girls believe they are loved and cared for are powerful forces (Cullen-DuPont, 2009). Emotional instability forms a powerful setting event, which makes the individual more likely to submit to the perpetrator. In the case of transporting a victim to another country, recruiters will promise better lives with lots of money, as they trick the girls and women into believing they will work as nannies, models, or maids (Landesman, 2004).

### **Perpetrator Profile**

It can seem impossible to get into the mind of the trafficker or perpetrator. There is no denying the heinous behaviors they exhibit and the activities they partake in as a part of their daily normalcy. In driving the chiefly male gender into organizing and facilitating the industry of

sexual exploitation there are many factors that may never be uncovered or at least understood. Globally, the beliefs of male superiority and male dominance have attributed to both the factors and functions of the involvement of men in TIP. Parallels are being drawn between characteristics of pimps and psychopaths, and although more conclusive research still needs to be developed, interpersonal and behavioral characteristics between the two seem similar (Spidel, Greaves, Cooper, Hervé, Yuille, 2006). Specific profile attributes that have been routinely observed in the tendencies of traffickers include glibness, or superficial charm, promiscuous sexual behavior, pathological lying, grandiose sense of self-worth, irresponsibility, high need for stimulation, callous, or lack of empathy, and lack of remorse or guilt (Hare, 1999). These traits could be used as possible precursors to the development of participatory behavior in trafficking. It seems evident how these different personality traits are associated, and manifested in the process of TIP.

### **Factors and Functions Behind Victim and Perpetrator Involvement**

For every behavior and lifestyle there is a reason behind *why* an individual participates in the identified behaviors. In the industry of TIP these functions or purposes can be difficult to recognize but crucial in helping to understand why this trade has become such a repulsive success. Research continues developing to identify functions and thus design interventions.

Largely the victims are exhibiting no choice in their involvement in their sexual exploitation. While on rare occasions the females may have displayed some degree of choice in their initial agreement, once faced with the gruesome reality of their use and disposal, they predominantly have no desire to remain in the business. They have truly been victimized with no say in their treatment or freedom. Abstractly, functions can be identified because there are cases where that initial decision to join the industry has been made freely. It can be said that TIP serves the function of providing for the victim's family, because in some cases the victim's family will receive a portion of their child's earnings. Another purpose for continuing in this sexual bondage could eventually be that the victim could not quit because she has accrued such a large debt to her trafficker. As corrupt as it sounds, the trafficker can use this factor to threaten the victim into complying (Clay, 2011). A further reason that the victim may stay trapped in the system and a function that the trafficking may serve is tied to emotional fulfillment. One study showed that emotional relationships are often manipulated, as one fifth of trafficked women in the United States were reported to have been in an intimate relationship with their pimps prior to or during their exploitation (Parrot & Cummings, 2008). The emotional and physical abuse in a person's past lures women into prostituting themselves and eventually can transform the individual into believing this is the only place they will be *loved* or *accepted*. Prostitution in particular is often viewed in society as a choice, and for some women it may be, but sex trafficking, while under very different circumstances, can form contingencies with identified functions.

Victims often feel forced to participate in prostitution or TIP to avoid negative consequences, or punishment that could otherwise follow. In some cases, the victims are providing money to their families so they can survive. Submission to trafficking therefore eliminates the aversives of hunger and deprivation for their loved ones. There are cases where victims partake in sexual exploitation to avoid very real and dangerous consequences, as severe

as abuse and death. By complying to sex and the instructions of perpetrators, women often can only focus on the fact that by doing so they are avoiding the punishment of death or abuse for any retaliation. Furthermore some victims may submit to the demands of the corruption in order to avoid the punishment of feeling worthless or unloved. As confusing and distorted as this seems at first glance, the perpetrators do a convincing job at making women feel like they are benefitting from the system. Particularly adolescents from broken pasts may view trafficking as a way to ignore and avoid the previous consequences of worthlessness that they have felt. Through all of these situations, participating in the behavior is altering the immediate or future consequence, which is motivating enough for them to take part in the degrading behavior of trafficking.

Although it may seem impossible for many human beings to comprehend, it is not out of the question for parents and families to willingly submit their child into the hands of a perpetrator. Recruiters will often approach rural families who find themselves in extreme poverty. When offered the opportunity of a better life for their child, and likely an exchange of money, the parents are blinded by the starvation, destitution, and helplessness that they find themselves in. Sadly the parents are all too often fully aware that the refuge offered for their daughter is in fact a brothel, but absolute desperation on the part of the family leads to consent (Cullen-DuPont, 2009). A family's economic status or emotional state can function as motivating operations to allowing a child to be sent into trafficking. Motivating operations are value altering, meaning the motivating operation (such as poverty) alters the value of a consequence of behavior by making it more or less reinforcing. In this case for the families, their poverty makes sending their daughter with a recruiter more reinforcing because the consequence of receiving money is a very strong reinforcer. Sending a daughter into sexual exploitation takes away a mouth to feed (negative reinforcement), and puts food on the table (positive reinforcement), both increasing the chance of behavior, and unfortunately often increasing the chance that families will send another child in the future. The rashness of a decision leaves parents unaware of what they are actually doing to their child, as they are promised that since they are failing to provide for their own child, they can simply send them away with someone who can do *better*. This again provides an example of recruiters and perpetrators taking advantage of people in vulnerable positions.

While a variety of elements may accumulate and create a function for the trafficker or pimp, the main and most highly supported purpose for the perpetrators to stay in the industry once they have been established, is the money. The annual global profit that traffickers make is astonishing; with a UN estimate that each year, human trafficking reaches a total market value of 32 billion dollars (Cullen-DuPont, 2009). The risk and penalties of getting caught are not heavy enough in comparison to the profit that is available to traffickers. The control and dominance that a trafficker feels, as previously mentioned, provides another major function of the behaviors. Satisfying the urge to display control is motivating. Reinforcing stimuli for traffickers such as money, control, social status, and the satisfaction of sexual desires, all increase the behavior that produced them, in this case exploiting the victims. While it would be helpful to blame a certain aspect of genetic makeup or an innate factor, the reality is that the many environmental variables

and personal choices create a confusing web when trying to sift through the potential causes. Instead these motivating factors provide a greater deal of insight.

The customers, or individuals who solicit the industry (labeled as johns) are participating in the illegal behavior to serve some sort of function as well. The most conclusive reasons have emerged as satisfying sexual desires and longings, exhibiting a risqué personality, financial profits, and the supply or availability of the services are encouraging of their involvement (Parrot & Cummings, 2008). Men seek the sex industry for functions including their longings for an otherwise unobtainable type of sexual activity, fruition of a romantic fantasy, the thrill and excitement, to exercise control and power over a helpless being, and to release accrued anger (Yen, 2008). TIP, through the sexual exploitation of women has become emerged as an acceptable mean to satisfy these urges. Designing a model to intervene in TIP can be daunting. The most appropriate interventions seem to be those that diminish the demand and evoke community action.

### **The Demand for Sex**

The demand side of the industry is one that does not receive nearly as much attention as that of supply. Yet the purchasing of sex must first be seized in order stop further development in the process of TIP (Clay, 2011). The male demand for sex sustains the industry. While a man's desire and need for sex is not a crime, ways in which this demand is being satisfied are. The demand truly *creates* the supply; because there exists a clientele willing to pay for the use of people, the industry continues (Cullen-DuPont, 2009). Human life is turned into a commodity for the pleasure of the buyers. The behaviors of human trafficking are occurring largely because there is an alluring antecedent of demand. The antecedent "sets up" the occurrence of behavior. In decreasing the demand or altering the antecedent (although complete elimination of the antecedent is ideal, it is not logical), the chance or rate of behavior also decreases. In the case of TIP it will be a difficult task to lessen the demand and diminish the supply, but being aware that the consumers influence the inventory is important.

### **Interventions**

#### ***Motivating Operations***

Through addressing various elements, action taken as a community should be effective. As noted as a factor in a family's push to submit their children into trafficking, familial poverty is a complete issue in and of itself. Studies and movements are continually being established to improve impoverished communities and nations. It is apparent in the case of TIP that if we remove poverty (a motivating operation or setting event) the behavior should be less frequently evoked. A few examples of methods to keep families from exploiting their children include establishing alternative ways for a family to make an income and increasing education. Particularly providing alternative modes of income should be in a way, implementing differential reinforcement of alternative behaviors (DRA). DRA is implemented by providing reinforcement for an alternative response to the problem behavior, which simultaneously extinguishes the undesired behavior. This new alternative behavior competes with, and will hopefully replace, the previously undesired behavior (Cooper, Heron, & Heward, 2007). While the new response may

not be topographically incompatible with exposing a child to TIP, the consequences of the new and alternative response should be more reinforcing, if the family is making enough money to survive and provide for the members of the family. The reinforcing qualities of the alternative response would extinguish the undesired or problem behavior.

### ***Awareness***

Education adds a vital step in the intervention of TIP and in this case it refers to the advocacy and awareness of the global issue. Many people are unaware of the high frequency of trafficking within their own borders and it is suggested that the epidemic of TIP become more prevalent in the news, schools, and training for various employment positions. By increasing awareness more efforts could hopefully be made to advocate for change and reform. Particularly in the case of laws and regulations (which have been identified as weak links in the realm of consequences), making the issue of TIP known would likely spur others on to call for change, making the consequences more aversive for perpetrators, and the behaviors more difficult to emit. Because of identified functions for the victims, such as avoiding punishment (abuse due to non-compliance), or gaining reward (acceptance, worth, love), education should also address these domains. Teaching teens appropriate ways to identify perpetrators, report violence, manipulation, and providing access to resources that support and build up this population, could hopefully make a difference. With the growing fraudulence of the traffickers, awareness of the problem could prevent future occurrences (Clay, 2011). Education could also help in addressing the functions of the families that are satisfied through trafficking. Teaching about the dangers and profiles of recruiters particularly could gain heightened awareness in parents. Educating and making individuals aware of services or other methods that yield food, shelter, and other survival goods may also prevent families from looking to recruiters for relief. Through education it is hopeful that behaviors could be reduced if starting with early generations, the ability to identify and halt the motivations is established, as well as education of the public to distinguish alternate routes to satisfy the function of the behaviors.

### ***Corruption***

Corruption must also be addressed. The idea behind ending the corruption seems basic – the men and women who are put into authority to protect and defend, should be doing just that. Yet corruption enables the industry and the traffickers, as government and law enforcement become *blind* to the process, and ignore the signs of TIP around them (Hughes, 2004). Currently it is common for police officers to accept bribes to overlook trafficked women (Cullen-DuPont, 2009) and victims no longer feel safe seeking out positions of authority to escape or report (consequently stopping the cycle), because those meant to provide aid may be spurring on the industry that entraps them (Landesman, 2004). A multitude of cases have been reported when presumably trusted individuals (police officers, psychologists, lawyers, etc.) have been johns themselves. TIP could be significantly reduced if interventions and expectations were in place to guarantee the government and law enforcement were stopping the behaviors when they were detected, and in addition, if greater training on spotting victims or perpetrators was provided. In this way, a break would be made in the process of TIP. Minimized corruption and greater

enforcement of the laws would pose an increasing threat to perpetrators, and enforce the punishment consequences that are currently fairly weak.

### *Consequences*

The function of receiving money, satisfying sexual desire, and exerting control must be diminished, and by taking away these reinforcers, the perpetrators will be negatively punished from participating in the behavior. Since behaviors serve certain functions, which have just been listed for the perpetrators, interventions must include ways to provide alternative behaviors to serve those functions. Certain organizations may consider establishing programs that help men foster healthy alternatives. Psychological counseling may be needed to address certain issues such as control. An alternative behavior for the function of financial gains for instance, would be figuring out other possible employment options. Teaching about healthy sexual relationships could work towards the realization of safe ways that exist to fulfill sexual desires.

A final and key intervention in diminishing the foothold that TIP has in society today is making risks and penalties associated with participating in TIP stricter and more prevalent. A variety of laws and acts have been established into both the United States and United Nations protocols, yet it is easy to slide past the rules. By ending corruption as previously mentioned, consequently the risks will increase. The consequences are not as severe as they could be and therefore behavior takes place because the consequences are not strong enough to prevent the behaviors. All behaviors are a function of their consequences. Make the consequences more aversive for the perpetrators, and participating in the behavior will become more aversive. Currently perpetrators must find the rewards and benefits to outweigh the risks and consequences. Countries need to establish their anti-trafficking positions and plans so they can be facilitated effectively (Chuang, 2006). Change in public policy will reinforce the penalties that are involved in TIP. The country of Sweden provides a model showing the effectiveness of national regulation. A decade ago laws were passed that convict those buying the sex (the johns), not providing it (the prostitutes). Swedish laws also provide care, counseling, and resources for prostitutes to exit the business. Due to their efforts, Sweden now has one of the lowest rates of trafficking in the European Union (Clay, 2011). Sweden among other things is addressing the victim's function of partaking in the exploitation for the rewards of money, food, shelter, etc. If these supports were not in place, the offer of rescue from a brothel is less promising or intriguing because the victim will think about the life they had before, the things they lacked before, which prompted them to fall into the trap initially. By providing the services and goods, Sweden's laws are breaking the connection between the motivating operation and the behavior, as well as the behavior and the consequences. Before, poverty caused vulnerability to agree to the exploitation. Now, the victim is offered things to lift the burden of poverty in ways other than selling themselves. Before, participating in TIP provided shelter, food, and relationships. Now, being rescued provides these same things, and support. Change *is* possible when a country is firm in their repercussions and treatment of those who defy the rules. When the consequences (most likely in this case, positive punishment) of behavior are increased, the likelihood of individuals participating in the behavior

will decrease. People will engage in TIP as long as they feel no increased threat for their involvement.

### ***Stop the Cycle and Advocate for Change***

Even if a perpetrator is prosecuted or a brothel overturned, even after a victim is rescued, there is need for intervention. In order to stop the cycle, victims must be cared for after their removal. If the victim has no place to live or return to after their eviction, it is likely they will return to the streets, their past environment, and become prone to being victimized again (Bales & Soodalter, 2009). Efforts in Sweden show that support can facilitate change. The emotional damage in itself, from being treated as a commodity rather than a human, needs to be addressed. If nothing benefitted from the sex trade, there would be no facilitation of trafficking and transporting women, and if the falsified ideas about prostitution were abolished, no females would be tricked into pursuing the job (Hughes, 2004). Interventions will require that victims are reminded of the goodness and trust that can, and does exist in the world outside their brothel, or else society faces a never-ending cycle. Interventions that cut connections between their behaviors within the industry, and “good” things promised to them by their pimps and clients are beneficial.

The social validity of this epidemic is screaming to the world as basic human rights are being violated. Society certainly cannot allow for this industry to grow and infect nations any further. Psychologist Bryant-Davis begs, “Are we going to stay on the sidelines or are we going to use our science, our clinical skills and our advocacy opportunities to combat modern-day slavery?” (Clay, 2011, p.72). It is no doubt a complex and encompassing issue in our society today, but steps certainly must be made to stop the progression any longer.

Through multi-faceted efforts, it is with great hope that the prevalence of sexual exploitation in humans decreases dramatically. Behavior analysts claim that all human behavior is a function of its consequences, and when you break apart any behavior, different antecedent and consequential events can be seen as motivation for participating in the said behavior. Although the issue of TIP has many variables, the work of applied behavior analysis can hopefully emerge to establish interventions and procedures to restore justice for the victims, while providing remediation for those steering this disturbing industry.

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## **Effect of Durometer and Thickness on the Release Rates of Perfluorocarbon Tracers from Permeation Sources**

*Anya Bagnato, Mathematics and Actuarial Science, '14*

### **Introduction**

A tracer is any substance that can be easily or clearly monitored (traced) in the study media. Tracer technologies can be used in transport/dispersion studies, leak detection studies, and material location. Leak detection studies use tracers to locate and estimate leak rates in various scenarios. These can be as simple as colored dyes used to visually locate cracks and holes in tanks or as complex as mass spectroscopy detection of helium to find leaks in vacuum systems. In transport and dispersion studies, tracers are used to tag a medium to determine how it is being dispersed in a surrounding matrix.

Perfluorocarbon Tracers (PFTs) are colorless, odorless compounds that consist of carbon and fluorine atoms joined by single, covalent bonds. The seven PFTs that are measurable by the Tracer Technology Group (TTG) at Brookhaven National Laboratory (BNL) all are cyclic rings making them very active in electron capture detectors and hence lends to their low detection limits of 10<sup>-14</sup>g. Being at low background levels makes PFTs ideal for atmospheric dispersion studies. The PFT technology consists of the tracers themselves, injection techniques, samplers, and analyzers. PFTs have the following advantages over conventional tracers:

- Negligible background concentrations of PFTs in the environment. Consequently, only small quantities are needed. The background concentrations are several parts in 10<sup>15</sup> ppq. The ppq of seven PFTs range from 1 ppq to 10 ppq.
- PFTs are nontoxic, non-reactive, nonflammable, the impact on the environment is negligible at the release rates used in tracer applications and therefore have no biological effects that are detrimental to the environment (Watson, 2007).
- PFTs are commercially available.
- PFT technology is the most sensitive of all non-radioactive tracer technologies and concentrations in the range of 10 parts per quadrillion of air (ppq) can be routinely measured. Thus, only a small amount of PFTs is needed in order to detect them above background.
- PFT technology is a multi-tracer technology allowing up to seven PFTs to be simultaneously deployed, sampled, and analyzed with the same instrumentation. This results in a lower cost and flexibility in experimental design and data interpretation. All seven PFTs can be analyzed in 15 minutes on a laboratory-based gas chromatograph.

Brookhaven National Laboratory (BNL) has developed a suite of PFTs (Watson, 2007). These tracers were originally used in atmospheric and oceanographic studies and have since been applied to a great variety of investigations, including detecting leaks in buried natural gas pipelines and locating radon ingress pathways in residential basements [2],[3]. PFTs have regulatory acceptance, and are used commercially (e.g. detecting leaks in underground power

cable systems). PFTs allow locating and sizing of leaks at depth, have a resolution of fractions of an inch and have been used in a variety of soils.

This technology has been used in major studies such as the Metropolitan Tracer Experiment (METREX) carried out in Washington, D. C. in 1984; the TransAlp program performed in Switzerland in 1989, 1990, and 1991; as well as the Urban Dispersion Program (UDP) conducted in New York City during 2005 (Watson, 2007).

The injection and monitoring of the tracers can be accomplished in numerous ways. The TTG uses direct discharge from pressurized gas cylinder, evaporative methods such as spinning cup “humidifiers” and permeation vial. Pressurized gas cylinders are limited to the dew point concentration, which changes with ambient temperature. Spinning cup and evaporative methods require external power to run the cup or heat the tracer to evaporate it. Permeation sources consist of a reservoir of tracer capped with a permeable membrane. The tracer diffuses through the membrane at a constant and known rate. This project focuses on the permeation source release method.

Permeation through a membrane occurs in several steps:

1. A molecule, in our case a PFT molecule, hits the surface of the membrane;
2. The molecule adsorbs/dissolves into the membrane;
3. The molecule diffuses across the membrane from the area of high concentration towards the area of lower concentration;
4. The molecule desorbs from the surface of the membrane.

The diffusion step (3) is generally the rate limiting step and is the most critical parameter in the permeation process.

The permeation can be described by Fick’s Law:

$$N_a = -D_a \left( \frac{dC_a}{dx} \right)$$

where:

$N_a$ = flux of permeating molecules of “a” (flow of molecules/area)

$D_a$ = diffusivity of component “a” in the membrane

$C_a$ = concentration of component “a”

$x$  = distance through the membrane

We measured the release rate or flux of the permeation sources while varying the thickness of the membrane ( $x$ ) and the diffusivity. The diffusivity is a function of the membrane and the solute. Since we were keeping the solute (a given PFT) constant, it was hoped the diffusivity would vary as the durometer of the silicone changed. [Concentration ( $C$ ) was constant through all the vials as it is 100% at the inside surface (reservoir side) of the membrane and 0% at the outside surface (room air)]. Durometer is a measure of the hardness of a material and is typically associated with polymers, elastomers and rubbers. Since all of the membranes being

tested are silicone (excellent PFT permeation compared to other polymers) it was expected that the degree cross-linking of the silicone would loosely correlate to hardness/durometer. Hence, durometer could be correlated with the membrane diffusivity (Da) as follows: For the silicone membranes that were all made from the same resins, using the same catalyst system and extrusion methods it was expected that the durometer would be representative of the cross-linking and density, both of which can affect Da. (Higher crosslinking and/or Density implies higher Durometer and lower Diffusivity)

TTG at BNL have known release rates calculated for permeation sources but they are limited. There is a need for a wider range of the release rates because each experiment is unique and requires different release rates. This can be achieved by varying the membrane thickness with the mega sources. Even though this can be calculated theoretically, there exist real-world limitations. Sealing the vials with thinner membrane can either stretch the rubber or create deformities while sealing, making the release rates slightly different from theoretical calculations. In addition, it was hoped that different durometer silicones would have different diffusion rates allowing further refinement of release rates. The objective of this research is to characterize the release rates of permeation sources using a variety of silicone membranes.

### **Materials and Methods**

While PFTs are released into the air via several methods, this project focuses on permeation sources. PFTs are released into the air passively using permeation sources which are made up of glass vials filled with a PFT. For this project, either Perfluoro-dimethylcyclobutane (PDCB) or Perfluoro-1,2-dimethylcyclohexane (o-PDCH) rubber with durometers of 10, 20, 40, and 70 and thicknesses of 0.01", 0.032", and 0.062" were cut out in circles of diameter of 13 mm using a cork bore. The vials were capped with different silicone rubber membranes. An aluminum seal was used to cap the vial and a crimping tool was used to seal it. One hundred and fourteen sources were prepared and kept at room temperature for four weeks. Each day the sources were weighed on a precision balance. The precision of the balance is  $\pm 0.0001$  grams. I checked the accuracy of weighing balance twice a week. The daily loss weight was calculated and weight loss versus time was recorded in an Excel file and the slope (rate) determined.

The vials with thickness of .01" bubbled up and thus did not give sufficient results. The rubber was too thin and the partial pressure of the volatile PFT was sufficient to cause the rubber to expand and form a bubble which changed both the thickness of the membrane and surface area. To fix that problem filter paper was cut out the same size as the membrane and new permeation sources were made up with several layers of filter paper on top of the membrane. The filter paper added rigidity and kept the membrane from deforming while allowing the PFTs to permeate unabated.

### **Results and Discussion**

The results from the research identified different release rates of different membranes as shown in Table 1. Characterization of these silicone membranes gives the TTG scientists a greater range of release rates for future experiments, and knowing which membrane to choose for a given release rate provides much greater flexibility in experimental design.

Deformation of the membrane was a major problem. The thinner membranes all deformed and “bubbled” due to the pressure of the volatile PFT contained in the vial. The bubble size was related to PFT molecular weight (hence volatility) as well as durometer with low (softer) durometer membranes deforming the most. The thinnest membranes (0.01”) had two problems; first they did not seal well due to being too thin for the sealing cap and second the deformation. An attempt was made to counter act these problems by placing a reinforcement layer of filter paper above the membrane. The filter paper would add strength to keep the membrane from deforming and thickness to help in sealing the membrane. In both cases with and without filter paper, the release rates were highly variable; to the point of not being consistent enough to use. Therefore, thin membranes are not advised for permeation sources.

As mentioned earlier, the softer membranes deformed more than stiffer (higher durometer) membranes. Some deformation occurred on the thicker membranes as well. Bubbles formed on membranes with thickness of 0.032" and durometer 10 (only one durometer for this thickness was used), and for 0.062" membranes with durometers of 10 and 20. The data for these softer membranes was often highly scattered as seen in Figure 1. Due to this scatter, it is recommended that silicone membranes for permeation sources have a durometer greater than 20. Table 2 states different thicknesses and durometers used with different kinds of PFTs and indicates which are useful and which are not useful.

The two PFTs being released had different release rates. This can be seen in Figures 1 and 2 which shows the weight loss for membranes of thickness of 0.032" and durometer of 10. PDCB releases faster than o-PDCH. The release rate of PDCB is 0.0102 grams per hour as seen on the Figure 1 and with standard deviation of 0.0074 and the release rate of o-PDCH is 0.0016 grams per hour as seen on the Figure 2 and with standard deviation of 0.000057. There is a difference in the release rate because of the molecular weight of the PFTs [1]. The molecular weight of PDCB is 300 grams per mol and of o-PDCH is 400 grams per mol [1]. The heavier PFT diffuses slower through the silicone.

Membrane thickness also affected the release rate. Diffusion of PFTs was slower through thicker membranes as seen in the Figure 3 and Figure 4. In both Figures, the durometer of the rubber is 40 and the PFT is PDCB in the vials. The release rate of the membrane with thickness of 0.01" was 0.0095 grams per hour and with standard deviation of 0.0021 and the release rate of the rubber with thickness of 0.062" was 0.0019 grams per hour and with standard deviation of 0.000072. The release rate of rubber with thickness of 0.01" is five times faster than for the rubber with thickness of 0.062".

Durometer did not affect the release rate. Figure 5 and Figure 6 depict the release rates of PDCB through membranes with the same thickness of 0.062" but with durometer of 10 and 20 and there is no difference in the rate. The release rate of rubber with durometer of 10 is 0.0022 grams per hour and with standard deviation of 0.00016 and with the durometer of 20 is 0.0021 grams per hour and with standard deviation of 0.00025.

One exception was noted for the membrane with a durometer of 70 as seen in the Figure 7. The rate was about half compared to the trend as it is 0.001 grams per hour and with standard

deviation of 0.00011. The average rate of the trend is seen of the Figure 6 which is 0.0021 grams per hour. This was attributed to the fact that this silicone used a catalyst (viz., platinum) in the polymerization process different from the other silicones, resulting in a denser material and, hence, slower diffusion.

The rate through a given membrane is inversely proportional to the thickness and should be a direct ratio of the membranes thickness for a given surface area. After all the release rates were normalized by thickness, only four membranes did not match the standard permeation membrane. These included the highly scatter 0.01” membranes, low durometer 0.032” membrane and the 70 durometer 0.062” membrane.

Tables 1 and 2.

PDCB		
Thickness in inches	Durometer	Average Rate (g/hr)
0.01	10	-0.012292
	20	-0.01329
	40	-0.009971
0.01 with filter paper	10	-0.01594
	20	-0.014598
	40	-0.01496
0.032	10	-0.012959
0.062	10	-0.002123
	20	-0.002108
	40	-0.001829
	70	-0.000983
	std. BNL	-0.002486
o-PDCH		
Thickness in inches	Durometer	Average Rate (g/hr)
0.01	20	-0.006786
0.01 with filter paper	20	-0.01372
0.032	10	-0.001582
0.062	40	-0.001136
	std. BNL	-0.001208

Table 1. Release rates of PDCB and o-PDCH through different silicone rubber membranes with various thicknesses and Shore A hardness

Useful		Not useful	
PDCB		PDCB	
Thickness in inches	Durometer	Thickness in inches	Durometer
0.062	40	0.01	10
	70		20
	std. BNL		40
o-PDCH		0.032	10
Thickness in inches	Durometer	0.062	10
0.032	10		20
0.062	40	o-PDCH	
	70	Thickness in inches	Durometer
		0.01	20

Table 2. Combinations of thicknesses and durometers that are useful and not useful depending on the kind of the PFTs.

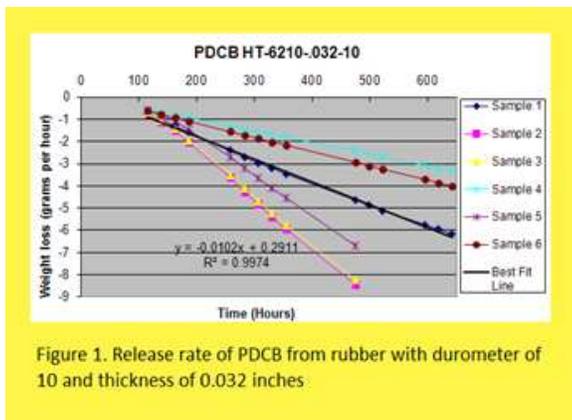


Figure 1. Release rate of PDCB from rubber with durometer of 10 and thickness of 0.032 inches.

Figures 1-8.

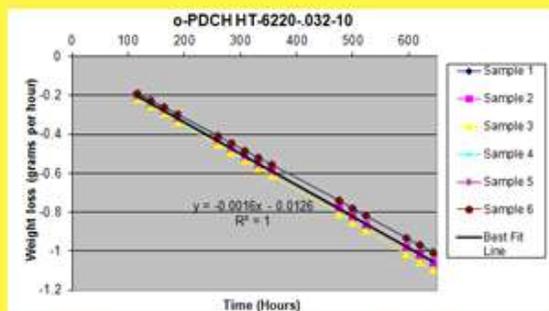


Figure 2. Release rate of o-PDCH from the rubber with durometer of 10 and thickness of 0.032 inches

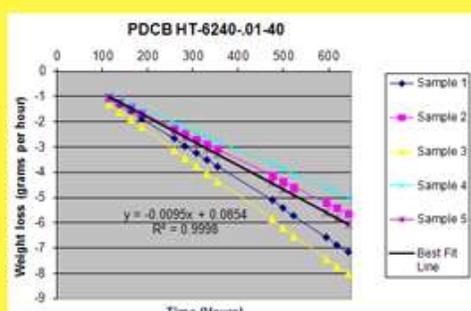


Figure 3. Release rate of PDCB from rubber with durometer of 40 and thickness of 0.01 inches

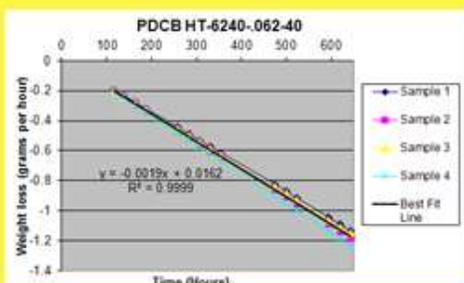


Figure 4. Release rate of PDCB from rubber with durometer of 40 and thickness of 0.062 inches

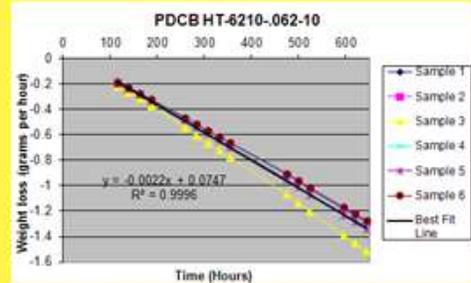


Figure 5. Release rate of PDCB from rubber with durometer of 10 and thickness of 0.062 inches

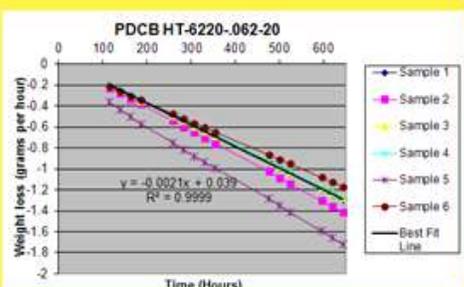


Figure 6. Release rate of PDCB from rubber with durometer of 20 and thickness of 0.062 inches

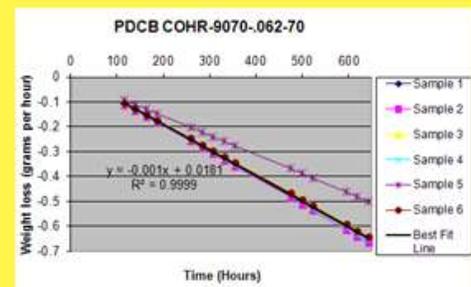


Figure 7. Release rate of PDCB from the rubber with durometer of 70 and thickness of 0.062 inches

## Conclusions

The release rates of the PFTs were calculated and showed the expected dependence on membrane thickness, but none with durometer. Also each PFT has its own release rate as can be seen in Table 1, which shows the rates for the different durometers and thicknesses. As seen in Figures 1 and 2, PDCB released faster than o-PDCH. Thicker membranes released slower than thin membranes as shown in Figure 3 and Figure 4, where both membranes have the same durometer. The use of different durometers did not affect the release rates. This is shown in Figure 5 and Figure 6. In both figures, both of the membranes have the same thickness and different harnesses yet the release rate is constant. One exception was noted for the membrane with a durometer of 70. Here the rate was about half compared to the trend as shown in Figure 7, which can be compared to Figures 5 and 6. Density is a factor that affects rate of as observed in membrane of 70 Durometer.

## Acknowledgements

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## **Evaluating pharmacy services satisfaction on psychiatric unit: An inpatient survey**

*Hannah Reichert, Health Sciences, '13*

### **Project Description**

This study analyzes patient satisfaction survey responses in which the patients evaluated their experience with the pharmacy staff in an acute inpatient psychiatric unit at Broadlawns Medical Center in Des Moines, Iowa. Broadlawns Medical Center periodically requests discharged patients to complete surveys pertaining to the performance of other health care providers in the mental health unit, however, the pharmacy staff were not evaluated in those particular surveys. The purpose of this study was to conduct a needs assessment of what the mental health unit pharmacy staff can improve upon in order to better serve patients. Upon discharge, eligible participants were given the opportunity to participate in the study by completing a paper survey. Surveys were collected during a five month time period.

### **Background**

Consumer satisfaction is commonly defined as, “a measure of the level and quality of service received by its consumers.” Previous studies revealed that a patient’s perspective of quality, effective service is often dissimilar to that of health care providers, administrators, and family members. A patient’s perception of their care influences their overall outcome of treatment. Psychiatric inpatients have clinical, social, behavioral, and cognitive needs that must be addressed in order for treatment to be most effective (Soergaard, Nivison, & Hansen, et al., 2008; Brunero, Lamont, & Fairbrother, 2009; Meehan, Bergen, & Stedman, 2002; Antyonysamy, Wieck, & Wittkowski, 2009).

Assessing psychiatric patient satisfaction is often controversial due to its high level of difficulty and reservations about its accuracy and sensitivity. However, the need for patient participation, data for quality assurance purposes, and obtaining a measurement of treatment outcome has increased the demand for patient surveys in the past decade (Meehan, Bergen, & Stedman, 2002). The patient’s mental health and other confounding factors can affect his or her responses to satisfaction questionnaires. Confounding factors may include age, gender, socio-economic status, level of function, acknowledgement of mental illness, subjective view on their quality of life, mood, clinical outcome, and often their diagnosis. Ultimately, survey responses are used to assist health care providers in developing interventions in order to increase patient satisfaction and better treatment outcomes.

Several previous surveys showed specific areas of patient concern. For example, it was found that mental health patients preferred to participate in developing their care plan with their clinicians rather than being denied participation in the process. Patients were found to be less likely to interact and seek help from their clinicians who appeared to be stressed. It was also determined that psychiatric inpatients rank their relationships with their health care providers as one of the most significant aspects of treatment (Antyonysamy, Wieck, & Wittkowski, 2009). The patient’s safety on the unit, ability to participate in organized activities, and discharge

support were also scored as significant factors in treatment (Soergaard, Nivison, & Hansen, et al., 2008; Brunero, Lamont, & Fairbrother, 2009; Meehan, Bergen, & Stedman, 2002).

It was the goal of the pharmacy staff of the mental health unit at Broadlawns Medical Center to maintain quality service, insure the best possible pharmaceutical education for the patients and fellow staff they serve, and to adhere to state and county regulations. The mental health unit psychiatrists at Broadlawns Medical Center preferred that the clinical pharmacist and pharmacy students educate as many patients as possible on their respective medications. In order to better assess these ongoing goals, feedback from patients became an essential component of the evaluative process. The pharmacy staff felt there was constant need for improvement, and feedback from patients was thought to help to clarify those specific areas of need. The purpose of this study was to conduct a needs assessment of what the mental health unit pharmacy staff at Broadlawns Medical Center could improve upon in order to better serve their patients.

## **Methods**

### ***Setting***

This study was a prospective investigation of patients who interacted with the mental health unit pharmacy staff at Broadlawns Medical Center in Des Moines, Iowa during a three month period, January 1st, 2012 through April 1st, 2012. The acute care inpatient unit has 26 beds and is the only county hospital in Des Moines. The pharmacy staff consists of a clinical pharmacist and two pharmacy students completing their advanced practice experiences.

### ***Participant Sample***

Criteria for participant inclusion were patients who met with a pharmacy staff member and discussed all criteria listed on the survey questionnaire at least once. Exclusion criteria consisted of patients who were not compliant with their medication(s), patients with cognitive deficiency which inhibited them from giving informed consent to participate (ie. dementia, mental retardation, or other mental incapacity), patients who were uncooperative with staff, patients who had difficulty concentrating, and patients who were actively confused and required staff assistance.

### ***Assessment of Satisfaction***

This study was conducted using a patient questionnaire to evaluate the participant's experience with the pharmacy staff in the mental health unit. The 13-item survey allowed participants to rate the pharmacy staff on a 3-point response scale including 'satisfied', 'neither satisfied nor dissatisfied', or 'dissatisfied'. Age and gender were also collected, as well as a comments section to give patients the opportunity to add personal insights on their satisfaction. The survey was constructed by adapting questions from various previous mental health patient satisfaction surveys and by creating additional relevant questions in order to appropriately evaluate the pharmacy staff at Broadlawns Medical Center. Figure 1 depicts the survey utilized in this study. The survey was intended to be user-friendly, easy to read, easy to score, independently completed by the patient, and adequately cover all pharmacy staff evaluation topics. It was designed to take less than five minutes to complete. Basic descriptive statistics were used to analyze data using Excel.

**Mental Health Unit  
Pharmacy Services Patient Survey**

Please take a few minutes to complete the survey below. The purpose of this survey is to get your opinion about the pharmacy services provided to you. The results of this survey will be used to address how pharmacy services can be further improved for future patients.

Age:	Gender:		
<b>Pharmacy staff introduced themselves to you</b>	<i>Satisfied</i>	<i>Neither satisfied nor unsatisfied</i>	<i>Unsatisfied</i>
<b>Quiet and private meeting location</b>	<i>Satisfied</i>	<i>Neither satisfied nor unsatisfied</i>	<i>Unsatisfied</i>
<b>Pharmacy staff identified the purpose of their visit</b>	<i>Satisfied</i>	<i>Neither satisfied nor unsatisfied</i>	<i>Unsatisfied</i>
<b>Kindness of pharmacy staff</b>	<i>Satisfied</i>	<i>Neither satisfied nor unsatisfied</i>	<i>Unsatisfied</i>
<b>Attitude of pharmacy staff</b>	<i>Satisfied</i>	<i>Neither satisfied nor unsatisfied</i>	<i>Unsatisfied</i>
<b>Had sufficient access to pharmacy staff</b>	<i>Satisfied</i>	<i>Neither satisfied nor unsatisfied</i>	<i>Unsatisfied</i>
<b>Pharmacy staff spent enough time with you</b>	<i>Satisfied</i>	<i>Neither satisfied nor unsatisfied</i>	<i>Unsatisfied</i>
<b>Pharmacy staff answered all of your questions</b>	<i>Satisfied</i>	<i>Neither satisfied nor unsatisfied</i>	<i>Unsatisfied</i>
<b>The purpose of your medication was explained to you</b>	<i>Satisfied</i>	<i>Neither satisfied nor unsatisfied</i>	<i>Unsatisfied</i>
<b>The length of time it takes for your medication to become effective was explained to you</b>	<i>Satisfied</i>	<i>Neither satisfied nor unsatisfied</i>	<i>Unsatisfied</i>
<b>Possible medication side effects were explained to you</b>	<i>Satisfied</i>	<i>Neither satisfied nor unsatisfied</i>	<i>Unsatisfied</i>
<b>Relevant medication interactions were explained to you</b>	<i>Satisfied</i>	<i>Neither satisfied nor unsatisfied</i>	<i>Unsatisfied</i>
<b>Pharmacy staff explained how and where to receive your medications after discharge</b>	<i>Satisfied</i>	<i>Neither satisfied nor unsatisfied</i>	<i>Unsatisfied</i>
<b>Other comments:</b>			

**Thank you very much for your response!  
If you have any questions please contact a pharmacy staff member.**

***Procedure***

All patients discharged from the unit were deemed psychiatrically stable by one of the unit's psychiatrists. The patient participants (n=31) were asked to complete the questionnaire prior to discharge. Patients who chose to participate were given a paper survey to complete at their discretion. Patients returned completed surveys to their assigned nurses in a sealed envelope. The nurses placed surveys in a designated survey box located on the unit, and study investigators collected the surveys once a week.

**Results**

A total of 31 patients participated in this study. Of the 31 participants, 10 patients were females (32.3%), 4 patients were males (12.9%), and 17 patients chose not to list their gender (54.8%). All participants were between the ages of 18-64.

The highest satisfaction ratings (more than 90%) were given for introduction (100%), identification of purpose (100%), kindness (100%), sufficient time spent with patient (96.8%), attitude (93.5%), answered all questions (93.5%), and the explanation of relevant medication interactions (90.3%).

More than 80% of patients were satisfied with the explanation of their medication's purpose (87.1%), explanation of the time it takes for the medication to become effective (83.9%), explanation of possible medication side effects (83.9%), and the explanation of how and where to receive medications upon discharge (80.6%).

The two items with the lowest satisfaction ratings were the selection of a quiet and private meeting location (77.4%) and sufficient access to pharmacy staff (77.4%). Table 1 outlines the survey items and subsequent satisfaction ratings.

**Table 1.** Patient responses to items of the pharmacy services evaluation survey

Item	Satisfied <i>n</i> (%)	Neither satisfied nor dissatisfied <i>n</i> (%)	Dissatisfied <i>n</i> (%)	No Response <i>n</i> (%)
Introduction	31 (100)	---	--	---
Quiet and private meeting location	24 (77.4)	5 (16.1)	2 (6.5)	---
Identified the purpose of the visit	31 (100)	---	---	---
Kindness	31 (100)	---	---	---
Attitude	29 (93.5)	1 (3.2)	---	1 (3.2)
Sufficient access to pharmacy staff	24 (77.4)	7 (22.6)	---	---
Sufficient time spent with patient	30 (96.8)	1 (3.2)	---	---
Answered all questions	29 (93.5)	---	2 (6.5)	---
Purpose of medication was explained	27 (87.1)	3 (9.7)	1 (3.2)	---
Time it takes medication to	26 (83.9)	4 (12.9)	1 (3.2)	---

become effective was explained							
Possible medication side effects were explained		26 (83.9)		5 (16.1)		---	---
Relevant medication interactions were explained		28 (90.3)		3 (9.7)		---	---
Explained how and where to receive medication upon discharge		25 (80.6)		4 (12.9)		1 (3.2)	1 (3.2)

## Conclusions

Broadlawns Medical Center periodically requests discharged patients complete surveys pertaining to the performance of other health care providers in the mental health unit, however, the pharmacy staff were not evaluated in those particular surveys. The purpose of this study was to evaluate the mental health unit pharmacy staff and to determine what areas they could improve upon in order to better serve their patients.

Data collected from paper surveys completed by patients at discharge concluded an overall high level of satisfaction (77.4%-100% satisfaction reported on every surveyed item). Results supported that pharmacy services were particularly proficient at introducing themselves, identifying the purpose of their visit, spending sufficient time with patients, answering all questions patients asked, explaining relevant medication interactions in a manner that patients understood, and were sincerely kind and had a positive attitude. In addition, data showed pharmacy staff were skillful with their explanation of patient's medication purpose, the time it takes for the medication to become effective, possible medication side effects, and how and where to receive medications upon discharge.

Results also showed two specific areas the pharmacy staff could improve upon in the future. Patients rated pharmacy services the lowest on 'quiet and private meeting location' and 'had sufficient access to pharmacy staff,' with both items scoring 77.4% satisfaction. The pharmacy staff could improve their communication with patients by selecting a quiet meeting location which can often be difficult to find given the number of patients and limited space on the mental health unit at Broadlawns Medical Center. However, if a quiet and private meeting location is not selected, patients could be easily distracted from their conversations with the pharmacy staff and may not retain valuable information discussed. In addition, the pharmacy staff should make themselves more accessible to patients in order to better serve their needs. Because pharmacy services is a fairly new service offered at Broadlawns Medical Center, they do not have an office or space available for them to occupy on the unit. Therefore, the pharmacy staff completes much of their work in the nurse's station when they are not directly meeting with patients on the unit. In the future, pharmacy staff should mention to patients that they are located

in the nurse's station in order to make themselves more accessible to patients, or Broadlawns Medical Center might consider allocating a certain space or office area for pharmacy services allowing them to conveniently serve patients.

There are several limitations to this study. One study limitation includes the thought that previously admitted patients who participated in the survey could have compared their prior experiences with pharmacy services when rating their present satisfaction levels (Soergaard, Nivison, & Hansen, et al., 2008; Brunero, Lamont, & Fairbrother, 2009; Meehan, Bergen, & Stedman, 2002; Antyonysamy, Wieck, & Wittkowski, 2009). In addition, a previous study determined that higher satisfaction ratings could be due to poor survey design. However, this also suggests the psychiatric inpatients surveyed are capable of judging their level of satisfaction with pharmacy services, and that pharmacy services are consistent in their patient care. When designing patient satisfaction surveys in the future, additional patient response options should be provided ('poor', 'fair', 'good', 'very good', and 'excellent'). These options support fair response variability and improve the sensitivity in survey design (Meehan, Bergen, & Stedman, 2002; Kravetz & Dasberg, 2002; Bjørngaard, Ruud, & Friis, 2007). Neutral scores could possibly be inferred as negative assessments, therefore, more qualitative methods are necessary (Brunero, Lamont, & Fairbrother, 2009; Meehan, Bergen, & Stedman, 2002). Open-ended questions should also be included to provide health providers with a better insight on what can be improved from a patient's perspective (Bhurgra, La Grenade, & Dazzan, 2000; Valenstein, Mitchinson, & Ronis, 2004). Other confounding variables that were not accounted for in this study, but could have likely skewed results, include age, gender, socio-economic status, level of function, acknowledgement of mental illness, subjective view on their quality of life, mood, clinical outcome, and often their diagnosis.

To conclude, this study demonstrates how essential it is to evaluate psychiatric patients' satisfaction in order to improve the quality of services provided and to find what is already working well for patients and staff. Health providers should work collaboratively with psychiatric patients in the future to further improve patient treatment and outcomes.

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## Oxidation of Alkenes, Triphenylphosphine, and Diphenylsulfide using the Dioxirane of 1,3 – Dichloroacetone

Jason Farver, BCMB and Chemistry '12, Bradley Swan, '11, Gholam Mirafzal, Professor of Chemistry

### Introduction

Oxidation is an important step in the synthesis of many organic compounds. The applications of oxidative processes range from the production of various pharmaceutical compounds to the important glucose oxidation that occurs in the human body. Although many oxidation methods are available, none provide selectivity for a single oxidized product. Dioxirane compounds have been used for oxidation reactions since 1979 but have not been tested for their selectivity properties. This research attempts to determine the sensitivity of dioxirane to the pi electrons of various styrene substrates, straight chain alkenes, sulfides and phosphines.

The theory is that the steric effects supported by interchangeable R-groups on the ketone co-reactants are sufficient in differentiating between multiple reaction sites, yielding selective oxidation. This concept was tested using a variety of ketones and alkene substrates.

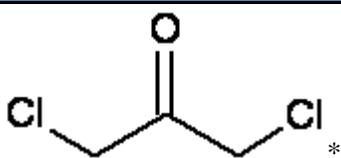
### Materials and Methods:

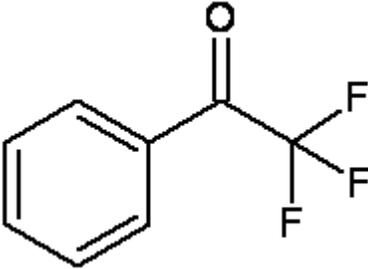
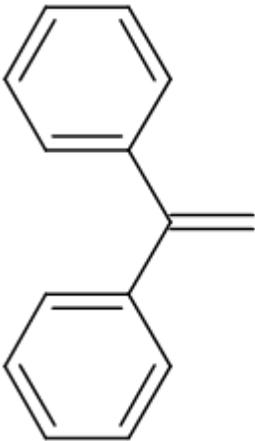
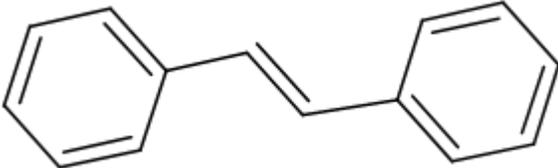
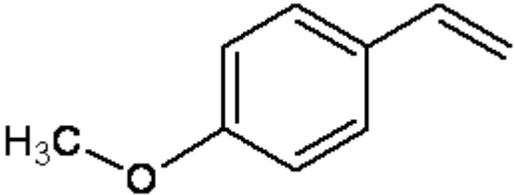
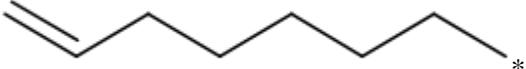
Table-1: Standard Materials

Compound Name	Chemical Formula	Purpose/Properties	Amount Used
Ethylenediaminetetraacetic acid (EDTA)	C <sub>10</sub> H <sub>16</sub> N <sub>2</sub> O <sub>8</sub>	Acid used to set pH of the solution	10mL of a 1.0x10 <sup>-4</sup> M Solution
Tetrabutylammonium hydrogensulfate	C <sub>16</sub> H <sub>36</sub> NHSO <sub>4</sub>	Phase transfer agent	0.015g
Oxone	KHSO <sub>5</sub>	Active oxidizing agent	Variable
Acetonitrile	CH <sub>3</sub> CN	Organic solvent	15mL
Sodium Bicarbonate	NaHCO <sub>3</sub>	Assisted in oxidation and acted as a pH buffer	Variable

The compounds listed in Table-1 were used in every reaction. In addition to these compounds, one to two alkenes, sulfides or phosphines and one ketone were used, as shown in Table-2.

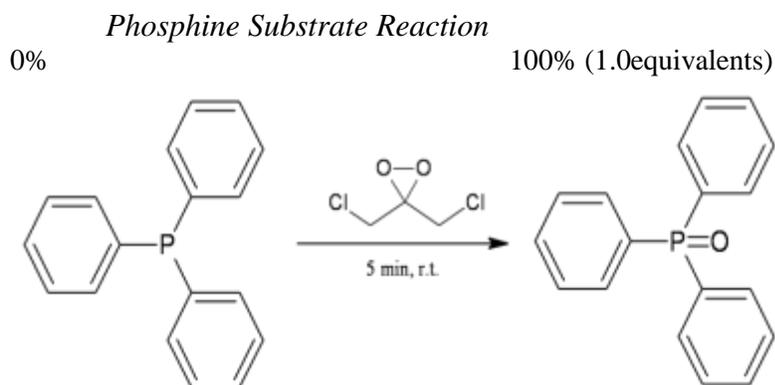
Table-2: Alkenes and Ketones

	Structure
1,3-dichloroacetone	

2,2,2-trifluoroacetophenone	 *
Name of Alkene	Structure
1,1-diphenylethylene	 *
<i>trans</i> -stilbene	 *
4-vinylanisole	 *
1-octene	 *
<i>cis</i> -stilbene	
<i>cis</i> -2-heptene	

These reactions were performed in a 50mL round bottom flask equipped with a stir bar. Competitive alkene reactions involved the use of one styrene substrate and one straight chain alkene, each in a quantity equal to 1.0mmol of the respective compound. The amount of Oxone used in these reactions was 0.1mmol, while 15mmol of sodium bicarbonate was used.



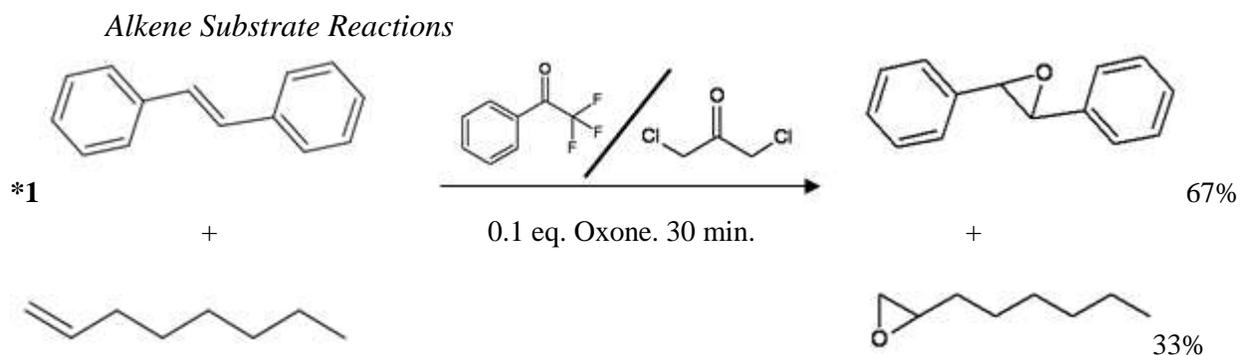


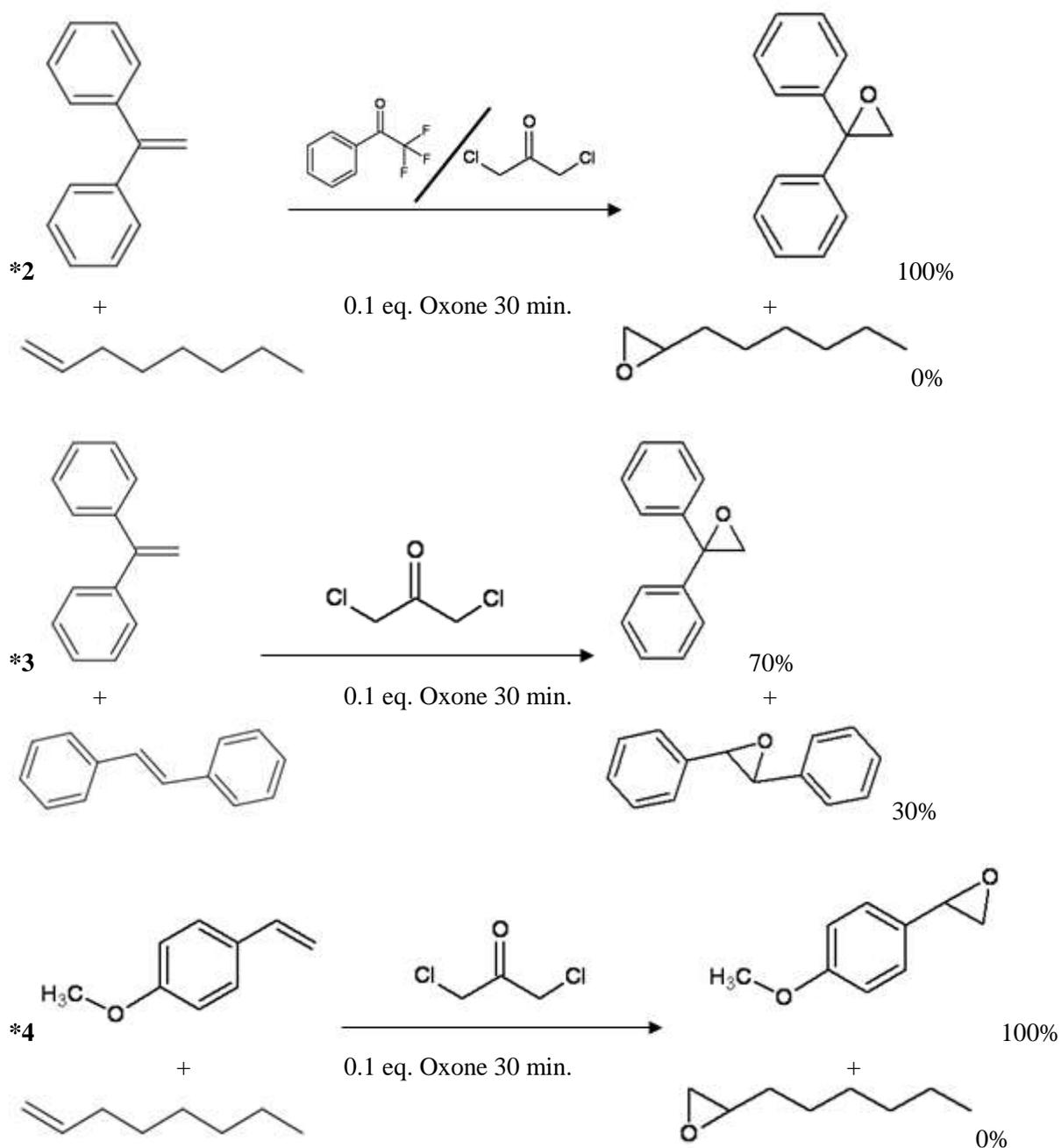
Seeing as the phosphine substrate, such as triphenylphosphine shown here, is capable of only one oxidation state, the careful measurement of Oxone for use in the reaction was unnecessary, such that a round 1.0 equivalent of Oxone was perfectly viable, as lesser quantities sometimes yielded less than full conversion to the desired oxidized product.

*Table 3: Response Factor Data and Retention Times for Diphenyl Sulfur Compounds*

<i>Compound Name</i>	<i>Response Factor</i>		<i>Correction Ratio</i>
Anisole*	18034.22111		1
Diphenyl Sulfide	39061.9455		2.17
Diphenyl Sulfoxide	50560.8857		2.80
Diphenyl Sulfone	53895.13777		2.99
<i>Compound Name</i>		<i>Retention Time (Min)</i>	
Anisole		~0.832	
Diphenyl Sulfide		~6.261	
Diphenyl Sulfoxide		~9.321	
Diphenyl Sulfone		~9.912	

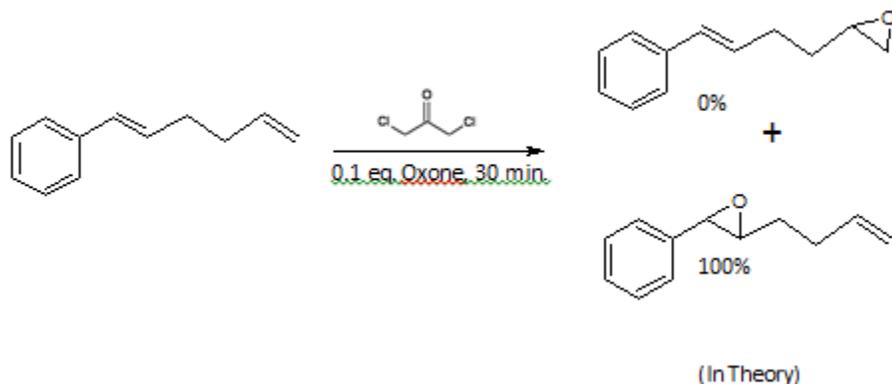
Response factors for the compounds in Table-3 were generated by dividing GC peak area by the molar concentration of prepared samples of each compound. These resultant response factors were then compared as a ratio to the response factor of the standard compound anisole, which in turn yielded the correction ratios used during experimentation.





Trials 1-3 follow the reactivity trend of styrene substrates, indicating 1,1-diphenylethylene is a more reactive pi-bond system than that of *trans*-stilbene. Not only is this confirmed in the styrene substrate and 1-octene combinations, but also in the direct competitive reaction between *trans*-stilbene and 1,1-diphenylethylene. The percentages shown are only ratios of the two products formed, as at 0.1mmol of Oxone, there was not enough active reagent to fuel a full reaction. This is because the low concentrations of active reagent produce better representations of kinetic differences between the two potential reaction sites, which is part of what was being tested.

Trial 4 was a preliminary reaction to confirm the kinetic favorability of 4-vinylanisole in relation to 1-octene. This was done to affirm the theory that if the two chemicals were to be “combined” as shown below, that a reaction run using a non-bulky ketone would select for the benzylic pi-bond as opposed to the terminal pi-bond. The compound described therein requires synthesis, and is not, as of yet, ready for use in the lab for experiment.



## Conclusion

So far there has been a good deal of success with the small-ketone selectivity, indicating that halogenated ketones with one or less benzene rings result in a selective oxidation of higher reactivity pi-bonds, all within thirty minutes of reaction time or less. Furthermore, one equivalent of Oxone is the necessary quantity of reagent to produce 100% conversion of triphenylphosphine into triphenylphosphine oxide, while only 0.6 equivalents were necessary to convert 98% of diphenylsulfide into diphenylsulfoxide. This suggests that the Oxone reagent is a multi-oxygen transferring system, which is reproducibly supported by greater than 100% conversions in numerous trials, despite consideration for response factors and other margins of error. Diphenylsulfide could additionally be converted into 100% diphenylsulfone through the addition of 1.5 equivalents of Oxone, confirming original suspicions.

What remains to be accomplished is to identify a ketone that is bulky enough to impart too much steric hindrance to react with internalized and more reactive pi-bonds, but still be reactive enough to interact with terminal pi-bonds on a straight chain alkene. Once this ketone is found, both it and 1,3-dichloroacetone can be used to selectively oxidize each bond in a compound containing two separate types of pi-bond. One potential candidate that is currently being experimented with is the ketone 2,2',3,3',4,4',5,5',6,6'-decafluoro benzophenone. Preliminary results have yet to produce the desired effect, but much work remains to be done.

## Acknowledgements

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## References

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