Optimal Design Report:
Continuous Urinary Output Monitor

Client:
Dr. Leonard Eisenfeld
Manchester Memorial Hospital
860-463-7584

Faculty Advisor: Dr. Peterson

TA: Sarah Brittain
1. Optimal Design Project 31

1.1 Introduction

1.1.1 Background

Dr. Leonard Eisenfeld in conjunction with the Neonatal Care Unit at The Connecticut Children’s hospital, request assistance in the development of a device that will monitor the urinary output of infants. This monitor will allow the staff of both doctors and nurses caring for the infant, to maintain a watchful eye on hydration issues that might be foreshadowing more serious internal problems for the patient. Currently, in order to determine how much a baby voids hourly, a highly labor intensive process of weighing the diapers occurs. Prior to the baby wearing the diaper, it is weighed, and then once the baby voids the diaper is weighed again and the starting weight is subtracted from the final weight to get an idea of how much urine the baby outputted. The problem with this procedure is its immense spectrum of inaccuracy, where the presence of stool along with a void will create a sense of uncertainty at how much is stool and how much is urine. The presence of this combination directly affects the way in which the caretakers can use the gathered information to assist in providing the optimal care to the patient. The separation of stool and urine is crucial in understanding the patient’s health, and if a device implements a way to prevent the combination of the two from occurring it will change the way infants are cared for in the neonatal care unit.

Another way in which urine output is measured is the insertion of catheters. When using catheters, they are inserted into the urethra and carry out the urine to a concealed bag which allows for an increasingly accurate measurement of a void. However, the insertion of this device is considerably less difficult in female patients then male. In either case, both run the risk of infection and trauma to the urinary tract as it remains a foreign object that is not necessarily readily accepted by the human body. The inefficiency and lack of safety in both these current practices increases the need for an easier more efficient and safer way to measure urine, making the need for the design in development extremely prevalent in the current health care industry.

1.1.2 Purpose of the Project

Currently the design in development is a “catheterized diaper” which will implement the use of specified material to create a diaper that filters a baby's void enough so that the only thing undergoing analysis is the urine. The diaper will be layered, and promote filtration so that the urine is carried away from the body and transported into a measuring device, where the reading will be redirected to transmit to the bedside monitor.

The goal of the project is to create a more efficient way of measuring an infant’s urine during the most critical stages of their development. Through the analysis of the patient's urine dehydration issues can be addressed, as well as the possible analysis of acidity and electrolyte presence. The process to obtain the urinary data currently is unsanitary, making it extremely unsafe in the neonatal care units, as the septic diapers are constantly being handled when being weighed and moved throughout the room. While nurses can make
sure to wash their hands following the handling of the soiled diapers, a monitoring system in which the soiled diapers do not need to be handled at all is the ultimate design as there will be no chance of disease transmission if the nurse simply disposes of the diaper. This is also an extremely labor intensive process, requiring the nurse to be on the constant move following a feeding time for an infant. If the monitoring system was used to alert the nurses and physicians of when an infant is experiencing dehydration or a loss of electrolytes the nurse would only have to remain in motion if the alarm signals that there is a process. The collection and measurement of urine will allow for the data to be transmitted to a bedside monitor, where a continuous examination of the infant’s urinary output can be completed by the constant tracking that can occur in graph form to show the dips and dives that the infant’s health is undergoing.

Previously the theoretical device would be comprised of a sensor used to pick up on vital signs and bodily functions using a sensor to ultimately determine the size and volume of an infant patient’s bladder. The device would be placed on the patient’s lower abdomen, so as to remain in the diaper area and contain a sensor with signal reception and filtration in order to accurately display a wireless analysis. Ultimately the finished design will possess the power to use the received signal and send this signal to a monitoring system, where caretakers can look at the information and analyze the data in a way that will allow them to best care for the patient. The display system will also be attached to an alarm system which will allow for an alert of any problems or changes in the infants ability to void. The alarm is essential as the infants urine output is directly related to the amount of nourishment the baby may or may not need, as with infants, especially neonatal patients, feeding is extremely hard and often the caretakers require more information to decide how much food the patient requires. The urine output also directly relates back to internal, or septic, shock, as well as circulation and diffusion of oxygen in the blood of the patient. This device implements the use of sensors that are extremely expensive and will not fit in the constraints of the budget that will be mentioned before. By simplifying the place at which the urine is exiting the body it is easier to gather the void in order to analyze the urine.

1.1.3 Previous Work Done by Others

Currently on the market there is no device alike to the optimal design of a “catheterized diaper” in which the diaper is revolutionized to include features that essentially separate the urine output from the stool output in order to gather a result, and use the gathered result to create a data output. The implementation of this device in vivo will allow for the urine to be transported away from the body and then analyzed in a way that will produce beneficial alert systems, to alarm nurses and physicians of any decline in the patient’s health.

There is no medical device that accurately works in determining and analyzing the urine output of infants. The addition of this medical device will provide infant caretakers with a great piece of mind, no longer requiring the labor intensive process of weighing the diapers, and allowing for the immediate knowledge of the baby’s hydration through the use of the display and alarm system. The end goal was previously to develop a sensor device that will be attached to the infant’s lower abdomen that provides signal reception,
filtration, display, and analysis. This device will promote an easier, safer, and more accurate monitoring procedure that will better assess the patient’s immediate well-being, especially as it relates to their hydration. However, the end goal has been changed to corner the use of a “catheterized diaper” in the separation of urine and stool, and then move the urine away for analysis.

### 1.1.4 Optimal Design

The “smart diaper” or “catheterized diaper” was chosen as the optimal design as it solves the overall problem of urinary monitoring in infants, while remaining cost effective and allowing for the optimal care of the patient. The product will be developed to directly collect the urine output of a patient which will then be measured and displayed. The basic design is a “catheter diaper.” A funnel like system will be incorporated into the diaper that will collect urine from the patient. The funnel will have a mesh screen to prevent any solid material from entering the urine collection bag. The urine will pass through a semi-absorbent material that will prevent moisture from remaining on the patient and further filter out any solids without altering the urine volume. Lastly a slight vacuum suction will be applied to the diaper that is strong enough to pull any liquid out of the diaper and into the collection bag without irritating the patient. The urine will be measured outside of the body, so it can be easily analyzed.

Once the urine has been collected in a bag it will be measured for volume. The volume of urine will be measured either by weight, pressure sensors, or stretch sensors depending on cost and accuracy. The sensor information will be run through a software program similar, if not exactly, LabView. The calculated output will be displayed as a single value on the bedside monitor. If possible Bluetooth or other wireless systems will be used to allow the system to run wirelessly from the collection bag to the bedside monitor.

The design may be similar to the product “Go Girl” which is funnel like system that allows women to urinate while standing. The materials for this product will be examined for use in the smart diaper. Teflon will also be looked at as a non-reactive liner for the funnel of the smart diaper. Female hygiene products, such as pads, will be examined for their properties for the possibility for use for the mesh and semi-absorbent material for the inside of the smart diaper. The tubes collecting the urine and connected to the bag will be made from medical grade tubing used for catheters. The urine will be collected in the same bag used for collecting urine from catheters. The vacuum suction will come from a reversed fish tank air pump, and if the pump if found to be too weak, larger air pumps will be examined.

The smart diaper will allow for many advances in the future. The collecting of the urine in a bag will allow sensors to be added to display more vital information such as pH, electrolyte balance, and protein content. These are all important to monitor with NICU patients, especially when treating or monitoring dehydration. Health care professionals will also be able to visually examine the urine color and adjust fluid input as needed.

The problems that may arise with use of the smart diaper are mainly size related. A patient in the NICU can be a full term baby that weighs six or seven pounds or it could be a
premature baby that weighs less than two pounds. This large scale of sizes means that the smart diaper will have to be developed in multiple sizes to ensure an accurate and safe fit on each patient. Another concern is the ability to collect all of the urine from a patient that is on their back. The funnel will have to be designed with the correct angles to ensure that all of the urine is collected and properly moved away from the body.

1.2 Subunits

The Optimal Design for the continuous urine output monitoring system will be a redesigned diaper with a catheter like system attached. In short the new design of the diaper will allow for the collection of urine from a neonatal patient without the used of an internal catheter. The prevention of using a catheter will reduce the risk for infection and discomfort for neonatal patients. The subunits for these catheter diapers are broken down by each layer found in the diaper and end in the software used to analyze collected data. Currently, five separate diaper sizes are used in the Connecticut Children’s Hospital. The final catheter diaper will also be produced in five sizes to meet the needs of the NICU. The final product will be a diaper with a single port that hospitals can used to attach to catheter bags.

Outside Layer

The outside layer of the diaper will remain the same material used in the diapers currently used in the NICU. The outermost material of a diaper is commonly polyethylene to prevent any leaks from escaping the diaper. This will ensure urine and fecal matter will not escape the diaper and cause any infection or discomfort to the patient. The outside layer was chosen to remain the same because it is a non-irritant to NICU patients and works efficiently to prevent any leaks in the diaper. The same Velcro used to secure the diaper onto a patient will be used for the catheter diaper. Given the allotted time for the project, no designs will be added to the outside catheter diaper, but further generations of the product allow for design improvements.

Figure 1: Bottom view of the Outer Layer of the Catheter Diaper
The longer strips located on the bottom of Figure 2 will be on the backside of the diaper and be made from Velcro. Shorter strips on the top of Figure 2 will be on the front side of the diaper and be made from Velcro. These strips will be used to secure the diaper safely onto the patient.

**Back Section of Diaper**

The backside of the diaper used to collect fecal matter will remain the same technology currently used today. The absorbent layer will be made from the same synthetic polymers that diapers currently used in the NICU are made from. Given that the diaper will be divided into two compartments, there will be less room for feces then in a normal diaper.
The shape of the backside of the diaper will be adjusted in order to allow fecal matter to move down away from the body to prevent infections and rashes. If needed a different material will be tested for use in the backside of the diaper. Given that fecal matter contains less liquid than urine and is not sterile, it is important to allow the fecal matter to be absorbed deeper into the diaper rather than sit on the surface of the diaper.

If time allows, a color indicator will be added to the diaper to inform health personnel that stool is present in the patients’ diaper. The color indicator will be significant enough to allow medical personnel to visibly see the backside of the diaper contains feces. An indicator that will be tested for use in the back section of the catheter diaper involves changes in pH.

![Figure 4: Top View of the Back of the Catheter Diaper](image)

The thicker top layer in Figure 4 represents the absorbent layer that will be used to absorb fecal matter. There will be more of an indent to the layer that will help prevent fecal matter from remaining in contact with the patient’s skin. The indent was unable to be performed on SolidWorks at this time.

**Wall between Front and Back**

In order to prevent cross contamination of urine and fecal matter, a layered wall be implemented in the center of the diaper directly under the patients’ perineum. The wall will be made from polyethylene given that it is a non-irritating material for patients. Multiple layers of polyethylene will be combined in order to give the wall more structure than the outside layer of the diaper. The dividing wall will be tested for rigidity to ensure it is strong enough to prevent urine or fecal matter from entering the opposing compartments, but flexible enough to prevent irritation or lacerations to the patients’ body. The absorbent material used in the back of the diaper may be added to the top of the wall to help with comfort and also absorb any leaked fecal matter or urine.
Figure 5: Top View of the Divider Wall for the Catheter Diaper

The wall shown in Figure 5 will be comprised of multiple layers and will also have a slight dip in the center to prevent rough edges from coming into contact with the patient's skin or causing irritation from rubbing. The dip was unable to be performed on SolidWorks at this time.

**Front Section of Diaper**

A thin layer of permeable polypropylene may be used as a screen in the front of the diaper to ensure no fecal matter enters the catheter bag. The polypropylene layer will be as thin as possible in order to prevent urine from being absorbed into the layer. Testing on the absorbance of polypropylene layer will be preformed, and if found to be at all absorbent, the layer will be replaced by another non-absorbent material or completely removed. The front of the diaper will have no absorbent material like the back of the diaper, rather instead a semi-structured funnel system will be used to move urine away form the patient to prevent any infection or rashes. Slight padding may be added to the front of the diaper for comfort. The padding will be made out of the synthetic absorbent material used in the back of the diaper.
The funnel system, as seen in Figure 6, will be surrounded by a soft absorbent material that is also used in the back section of the diaper. The surrounding material was unable to be performed on SolidWorks at this time.
A tube ending in a port connecting will be added to the bottom of the front section of diaper. The tube addition and port was unable to be performed on SolidWorks at this time.

**Funnel system**

The funnel system will be similar to that of the GoGirl funnel on the market today, with major adaptations for neonatal use. The silicon based funnel will be placed into the front side of the diaper and be large enough to fully cover the patients’ vagina or penis. The funnel will be deep enough to prevent unnecessary force or pressure to be placed on male patients’ penises as well. If silicon is found to be unsatisfactory, Teflon will be examined for an alternative funnel material.

Given that NICU patients are often on their back, the funnel will be designed in order to collect urine with the use of gravity. The funnel will taper closer to the back of the diaper rather than the middle to allow gravity to be used to move urine down into the attached tubes. The backside of the funnel will also have a high wall to further prevent urine and fecal matter from contaminating. The funnel will have a slight edge surrounding the entire funnel to prevent any backsplash from exiting the funnel. The funnel will taper into a single tube output that will exit the bottom of the diaper. The end of the tube will have a port style attachment that will be used to connect to catheter tubing.
Figure 9: Side View of the Funnel system used in the Front Section of the Diaper

The funnel will be elongated in the back near the tube export to help gravity drain urine away from the body and into the tube to the catheter bag.

Figure 10: Cut Side View of the Funnel System used in the Front Section of the Diaper

**Tubing**

There will be a single tube port that will attach to the bottom of the funnel and exit the bottom of the diaper. This port will be made from catheter tubing and medical grade ports. A single tube will be attached from the diaper port to the catheter bag. The tubes will be medical grade catheter tubes in order to ensure the catheter bag can be securely attached. The catheter tubing will be tested to ensure the flexibility properties are adequate to be used around patients given the limited space around a neonatal patient. If the tubes are found to be too rigid, alternative medical grade tubing will be examined and used if necessary. All five different size diapers will have the same size ports to prevent hospitals from unnecessary spending.
The tubes will be used in the front section of the diaper to drain urine from the funnel to the outside of the diaper. The ports seen in Figure 11 will be used to connect another catheter tube to the catheter bag.

**Catheter Bag**

A neonatal catheter bag will be used to collect the urine from the diaper and the tubes. The bag will be clear with graduated markings to allow medical personnel to visually examine the urine output from the patient. The smallest available bag will be used to collect urine in order to prevent needed space around the patient from being used up by an oversized collection bag. If a small enough bag is unavailable, one based off of the common catheter bag will be designed. The bag will be hung from a scale in order to collect the weight of the urine.
If time allows multiple sensors and indicators will be added to the catheter bag. pH will be examined using a pH probe, protein levels can be monitored to ensure proper kidney function in the patient, and glucose levels can be examined. The pH level can be easily displayed as a single value on the bedside monitor and a color indicator can be used to show protein and glucose concentrations using urine strip tests that are currently on the market, such as Arkray Urine Test Strip DiaScreen 2GP.

**Urine Weight Measurement**

A hanging scale will be used to measure the weight of the catheter bag. The scale will have a high accuracy level to at least the thousandth decimal point in order to measure the slight differences a small bladder void would produce. The scale will output a single weight to a computer program wirelessly using Bluetooth or an equivalent system. After each emptying of the catheter bag, the scale will have to be tarred in order to ensure the scale only collects the weight of the urine.

![Figure 13: Hanging Scale](image)

The catheter bag will be attached to the clip at the bottom of the scale. The scale will have to be modified to wirelessly transmit weight.

**Software**

The weight measurement will be collected into a LabView program. Given that the scale is tarred after the addition of the catheter bag, the produced weight will only be that of the urine. The weight will then be calculated into volume using the average density found for neonatal urine. The final output will be in cc/hour. The final calculated value would be displayed on the bedside monitor. Bluetooth or an equivalent system will be used to send final data wirelessly. The program will have a simple interface to prevent unnecessary software training for medical personnel. The program will also allow for alerts to be added for individual patients. These alerts will include hydration problems such as lack of urination for a set amount of time or the production of too much urine in set amount of time. The urine data will be saved for 24 hours with the possibility of medical personnel to save any section of the data into the patient’s medical records.
Testing

The analysis of the concept is based off of the majority of the materials being used for the catheter diaper are currently being used for normal diapers today. Until a prototype of the final product can be created, testing on urine collection can't be thoroughly analyzed. A medical grade infant test dummy is too expensive for the given budget. A lifelike urinating and defecating doll will be purchased if possible to test prototype catheter diaper. If robotic doll is unavailable, a simple testing machine will be built to test the functions of the diaper. Testing on the absorbency of current materials will be done using lab generated synthetic urine. If medical grade synthetic urine is unavailable or too expensive for the budget, urine used to falsify drug tests may be used. The silicon material will be tested for surface properties to ensure that the surface is highly hydrophobic to promote urine drainage down to the catheter tube.
2 Realistic Constraints

In order to develop a successful product that accomplishes the overall goal of monitoring an infant patient’s urine output, many aspects have to be taken into account to make sure the device will function in reality. One of the most important factors is cost, the cost not only to build the product, but also the resale value of the device. If the device costs too much money to produce, it will most likely cost too much for many hospitals to be able to implement the device into their daily caretaking routine. The budget of one thousand US dollars for two products eliminated the use of ultrasound sensors, as the use of one sensor was not beneficial. The cost of multiple sensors would use the entire budget on the Urinary Output Monitor, and still would not provide all of the materials required to develop a product that would accomplish the end goal. The “catheterized diaper” will use materials that are feasible, while also implementing the use of feasible software that will be provided free of cost. The development of the product will be extremely cost effective, and will therefore be more likely to be resold to hospitals that are looking for less expensive ways to improve care for all patients.

When the device is placed in vivo it needs to use electrical and wireless currents that will not interfere with any other technologies being used in the neonatal care unit simultaneously. Currently, devices as simple as cell phones are banned from use in the NICU as testing is being done to prove that the signals cell phones emit interfere with respirators overall function. The infant’s void will be carried away from the body to a weighing and measuring device, where the data will be collected and sent to the bed side monitor to create a constant flow of data. The data will be sent wirelessly using a Bluetooth transmission. This exchange of data cannot cause any interruptions in the care of infant’s using other devices. It is extremely important that the signals do not interfere, as one momentary lapse in care from any of the machines in the NICU could be fatal to the child depending on it to eat, maintain body temperature, or even breathe for them. While the interference is extremely important to take into consideration, the wireless signal also needs to remain strong enough to transmit. If the infant is relocated to somewhere in the NICU the signal still needs to remain strong enough in order to transmit the signal back to their bedside monitor so that nurses and doctors and constantly remain aware of the infant’s urine output. The alert system put in place to warn caretakers when the patient’s output is extremely low, or lacking electrolytes or the pH is extremely off, needs to be one that will provide the doctor’s with the knowledge that the infant is in distress. However, in the NICU many infants are extremely sensitive to both light and sound, Therefore the alarm sound cannot be too loud to cause harm to not only the infant being monitored, but also the other infants being treated in the NICU.

Overall the device in development has to remain durable for extensive amounts of time. The diapers can be only be used once, as once they are soiled they will be contaminated and reusing them will only increase the chance of spreading disease throughout the NICU. However, the measuring component of the diaper can be reused as the catheterization port at the bottom of the diaper will be a standard part of every diaper used regardless of the size of the diaper being used. The catheter port will remain a constant size, but the sizes of the diaper will have to change accordingly.
infant will not be able to fit into a diaper with a funneling system that a full term baby will fit into. Normal diapers for infants in the NICU vary by five or six sizes, and therefore in order to accommodate for the difference in size the “catheterized diaper” will also come in multiple sizes for infants.

The manufacturing of the diaper will be accomplished by using materials specified above, to create a filtration system that will ultimately gather the urine to be analyzed and further examined to determine its relation to the infant’s health. The materials required for this “catheterized diaper” are mainly inexpensive, and can be implemented in a diaper that can be mass produced to reach a large population in need of an easier way to measure Urinary output. The software that will be used to output the overall data collected from the urinary collection is inexpensive and once the program is developed it will be easily implemented in bed side monitors so that the constant analysis of the urine output will be easily displayed and readily available for analysis of the infant’s health.

In many cases the evaluation of the urine provides a detailed analysis that will promote the treatment of patient’s that could have extremely serious medical disabilities. This is an ethical issue that is currently being discussed in relation to most every device that promotes the treatment of children that have preexisting disabilities. When providing this type of care the physician’s first obligation is to first do no harm. However, the increase in the number of disabilities in the population is a result of certain extreme measures taken to maintain living functions for children that may have suffered from a brain injury or an internal malfunction. These disabilities often lead to a lifelong struggle that is extremely care and cost intensive for both the patient’s and caregivers.

The patient’s health is the number one concern, while also accomplishing the overall goal of monitoring urinary output. The device must not pose long term health problems for the patient, there for biocompatible materials were chosen carefully to ensure that their use will not cause inflammation or irritation when placed on the patient. When the device in place its shape and structure must account for the shape and size of the specified infant and therefore the placement of the internal structures must not cause any harm or irritation at the site of placement. The safety of the infant is again heightened and therefore must remain a primary concern of the design. The diaper must be made of a material that will not scratch or irritate the infant. It must accomplish its job while essentially remaining un known to the child that it is placed on. The materials that were chosen in the developmental stages of our design were done so in order for the child to remain completely unaware and unimpeded by its presence. Any type of device that is used in a neonatal care unit must always remain under the scrutiny of heightened safety. When an infant is the primary patient that will be exposed to the device, it must be “safety proofed” so that the only function that it serves is to better the patient’s quality of life. The device should not cause any harm or irritation, as many infants in the NICU are already facing life altering disabilities, and are struggling to survive in a world they were not ready to enter yet. The introduction of a device that in some way causes patients additional pain or problems, no matter if it accomplishes the goal or not, is one that is useless in the world of Neonatal Care Units worldwide.
3 Safety Issues

Dealing with infants creates the need for a heightened sense of safety when it comes to the design of a product that will be used to care for them. The majority of safety issues that are involved with the catheter diaper surround the materials used in the diaper itself. All the materials used have to be nonirritating and nonreactive with the patients’ skin and body fluids. In addition to the materials needing to be safe for a NICU patient, the entire product needs to be small and remain safely out of the way from the medical personnel. There is limited room around a NICU patient, and everything involving the catheter diaper, including the tubes, scale, and catheter bag, need to stay tucked away from medical personnel, especially in an emergency situation.

The majority of materials used in the catheter diaper have already been used, or are currently being used in normal diapers today. This is beneficial because no extended testing on patient safety is needed because the materials have already proven to be safe for the intended use. The silicon funnel system is the only addition to the diaper that has not been proven safe with use in a diaper. The commercially available GoGirl female urinary device is currently made from a silicon material. This device has been tested and proven to be safe for use against the human body and safe to use with urine. Long-term use of this product would need to be tested to ensure safe use with NICU patients. The shape of the silicon funnel needs to have no sharp edges or cause any pressure points when placed against the patients’ skin. The silicon chosen for the catheter diaper needs to be slightly flexible in order to allow the patient to move without causing any harm.

Any indicator added to the back section of the diaper for fecal matter indication needs to be safe to use with patients. The chemical needs to either nonreactive with human skin to prevent the body from absorbing the chemical, or the chemical needs to be safely contained in the diaper so that it never comes in contact with the skin. If the chemical is contained away from the skin, additional safety measures and backups need to be included in the design so that it is impossible for the chemical to have a negative effect on the patient. Given that the fecal matter indicator is an added feature, if a safe chemical is unable to be found, it will be removed from the design in order to prevent any unnecessary danger to the patient.

The dividing wall added to the catheter diaper will help keep urine and fecal matter separate, but it adds safety issues to the patient. The wall needs to be made out of a material that will not irritate the skin when placed flush against the body for long periods of time. The material must also be soft and flexible enough to not cause lacerations on the patient. NICU patients’ skin is incredibly soft and sensitive so any slight pressure or slight edge to the material could cause lacerations, which could lead to infections.

The tubes and ports leaving the catheter diaper need to be secured and placed in specific locations in order to prevent tubes from becoming tangled around the patients legs or hard plastic ports from harming the patient. Again if the hard plastic ports come in contact with the patients’ skin, the hard plastic could lacerate the skin and cause infections. There are no real safety issues with the use of a scale and catheter bag. Neither device will come in immediate contact with the patient.
4 Impact of Engineering Solutions

The implementation of the “catheterized diaper” in hospitals globally will increase the cleanliness and efficiency of measuring the urinary output. By using this device it will help caretaker's eliminate a great deal of physical labor and provide them with an easier way in which to account for fluid loss during urinary output. The urinary output is critical in determining the health of the baby. The device will allow for the urine to be removed from the body and placed in a container where multiple tests can be performed to better evaluate the internal health of the infant. With the addition of this device the urine can only be further analyzed improving the ability of the caregiver’s to provide optimal care.

With the addition of multiple sensors the urine can be broken down into the most essential components of evaluation. The electrolytes can be evaluated to show if the nourishment the baby is receiving is the most beneficial amount and type, allowing them to receive all the proper nutrients and maintain positive stature of internal health. The future of this project could lead to areas of further analysis.

The use of the “catheterized diaper” globally will allow for a cost effective way in which people in all socioeconomic areas to measure urinary output and provide the care that would assist the patient in the most beneficial way. This will help to ensure that children in lesser developed countries be given the correct amount of nourishment. It is critical for children who are born into the world in such a sudden nature, to be monitored enough so that if they are in need of any type of nourishment or additional assistance they receive that care immediately in order to prevent any future harm from occurring to the infant. The infants in the NICU of lesser developed countries face the stronger possibility of mal nourishment, and through the implementation of the “catheterized diaper” caretakers will be able to further analyze ways in which to provide them with the nourishment that they require in order to maintain their health.

Environmentally as with all diapers they will create a more prominent need for a disposal system that will break down the components of the diaper so that when they are finally disposed of they do not present a burden on the environment. The use of a rubberized material could prove difficult in ensuring the ability to recycle the diaper and reuse the components. There are an extensive amount of problems with non biodegradable diapers that are filling up landfills globally. Hopefully, if the development of the smart “catheterized diaper” continues into the future a more biodegradable material can be developed, but in the budget constraints that the project is current subject to the only affordable material is one that is not totally biodegradable material.

The diaper will be used to provide better care for babies that are having internal difficulties producing urine, or sustaining the nourishment they have been give. The babies in the NICU often suffer a great deal from internal issues that they are subject to as an effect of premature birth, and in some cases their sufferings cannot be changed once the damage is done. When a baby is subject to internal damage in such an early stage of life, the damage can be irreversible and even thought the baby remains alive, their brain function or other bodily functions will be severely compromised. This device, along with any device that is used to promote the health of neonatal care unit infants, will therefore elongate the life of a baby that may have a life changing disability. This is something that brings up a very moral based debate, that comes into the spotlight more and more as extreme measures are being
developed to help keep infants alive even following the introduction of life altering disabilities. The current situation is that due to the increase in extraordinary measures being taken to keep these children alive, there is an increase in the amount of disabilities presenting themselves within the population. The treatment of these disabilities is also changing helping to integrate people with disabilities into the “mainstream” way of life. However, with regards to diseases such as mental retardation and cerebral palsy the children remain effected for the entirety of their life and while it is a positive that they remain alive, the struggles associated with these diseases are profound and require constant care.

5 Life-Long Learning

In any design process one of the most important aspects is the development of a new and useful product that will better the quality of care any nurse, doctor, or physician can provide to a patient. However, it is also important to note that while researching and designing a product, many new pieces of information present themselves and prove to be useful not only in implementation of the design but may provide a lifelong lesson.

Working in conjunction with a neonatal care unit doctor, it is very eye opening to see just the severity of being placed in an intensive care unit at such an early stage in life. Many of the patient’s in this unit are facing life threatening issues, and while the doctors will work to provide the best care, in certain cases the patients undergo problems that are irreversible and will face difficulties for the remainder of their lives. When these infants are subject to a loss of air or of nourishment they are experiencing a lack of brain activity or of specific organ function. The realization of what it means for a baby to be delivered seventeen weeks early was brought into focus, when it is said that the baby will undergo as much gestation, if not more, outside of its mother’s womb than inside.

The exposure to the way in which a hospital works is an invaluable lesson, as working with a doctor helps to see how time is managed between patients. In particular seeing the difference between a neonatal doctor and a normal physician is extremely interesting. Dr. Eisenfeld has patients at multiple hospitals around New England, and so far has exposed Team 17 to two very different NICUs. After seeing the NICUs and discussing the products with physicians it was clear that the cost of the product being implemented in hospitals was a key component to the design. If the design calls for an increased cost, it will in many cases remain too expensive to mass produce and implement in hospitals. Exposure to a hospital’s budget helps to increase awareness of keeping to the project budget.
6 References


Image References:


http://image.made-in-china.com/4f0j00ECLQwSnMEIqP/Suction-Tube-Suction-Catheter.jpg

