HAND AND UPPER EXTREMITY DONATION
A GUIDE TO CLINICAL AND FAMILY SUPPORT FOR ORGAN PROCUREMENT ORGANIZATIONS

by
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Abstract

Loosing a limb due to extensive trauma, severe burns, or from infection, can be devastating and mentally taxing on an individual. With the advent of Vascularized Composite Allotransplantation (VCA), individuals with amputated extremities have a new option: they can receive a donor hand or arm, in a procedure that is similar to the more traditional solid organ donation and transplantation.

Organ Procurement Organizations (OPOs) play a pivotal role in organ procurement: they are responsible for donor registration, and coordination of the donation process. Staff at OPOs need to have appropriate resources and educational material to guide their practices, however there is limited literature, lack of visuals, and no guidebooks or choreography on the recovery process of VCAs. The Living Legacy Foundation (LLF) is developing a guidebook to provide OPOs with the necessary training and education for their organization.

Five key steps in upper extremity VCA were selected for illustrations for the LLF guidebook: (i) tourniquet application, (ii) vessel dissection, (iii) possible levels of transection, (iv) perfusion process, and (v) prosthetic fitting. Quick reference guides showing the 3 pathways of VCA recovery were developed to help non-VCA teams with choreography in the operating room. Pen and ink was used for the illustrations for simplified schematic lines. An aerial view with icons was used for the VCA pathways for quick readability. Limited color was utilized on all images to draw emphasis and importance to specific elements.

There was a focus group held at the LLF where eight staff members filled out evaluation sheets for preliminary images and quantitative and qualitative data was
collected. Feedback was also collected from Dr. Brandacher and transplant surgeons. All recommendations were considered and revisions were made for all images.

Upon completion, the guidebook containing created visuals and text written by the LLF, will be distributed to their employees. If successful amongst the LLF employees, the guidebook will be presented to regional OPOs, professional societies and eventually to UNOS/OPTN for consideration as a nation-wide resource for all OPOs and VCA centers.

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INTRODUCTION

1. Overview of Vascularized Composite Allotransplantation and its Principles

Introduction and definition

The impact of losing a limb can be devastating and mentally taxing on an individual. The loss changes an individual’s quality of life, and even their outlook. When a patient has lost an extremity due to extensive trauma, severe burns, or from infection it decreases the individual’s quality of life and their ability to function. With the advent of Vascularized Composite Allotransplantation (VCA), individuals with amputated extremities have a new option: instead of receiving a prosthesis, they can now receive a Vascularized Composite allograft (VCa) such as a donor hand or arm, in a procedure that is similar to the more traditional solid organ donation and transplantation.

Vascularized Composite Allotransplantation is the process of taking a multi-tissue structure from a donor and transplanting it onto a recipient. The VCa consists of bones, muscles, nerves, blood vessels, and skin (Myast 2014). In VCAs, the combination of these different tissue structures are utilized as one functional unit for the recipient. There are different types of Vascularized Composite Allograft (VCa)s, ranging from face transplants to upper and lower extremity transplants. Extremity (VCa)s range from upper extremity, including arm, forearm, and hand, to lower extremity include leg grafts. In contrast, solid organ transplantation is life saving, does not contain many types of tissues such as bone/skin/muscle, and does not require motor and sensory nerve regeneration. Thus VCA differs from solid organ transplantation in its use of multiple tissue structures, and it is considered a non-life saving transplant. The VCa serve as a functional and aesthetic unit, which can help recapture the normalcy of everyday life for a recipient.
VCA are for those who are in good general health, are psychologically stable, and have also failed at a prosthetic usage trail (Hartzell et al. 2011). Once a VCA transplant has been given to the recipient, they have to go through extensive rehabilitation, and take immunosuppressants for the duration of their life to avoid rejection of the donated tissues. With the combination of post-operative rehabilitation and a lifetime of immunosuppressants, the recipient can regain full use of the face or extremity that was transplanted.

**Historical background**

The idea of transplanting extremities from one individual to another dates back to ancient times of human history. There is a myth of two Arabian saints, Cosmos and Damian, and their attempt to replace an amputated monk’s gangrenous leg with an Ethiopian Moor’s leg (Brandacher 2013). Man’s fascination with the idea of extremity transplantation continued throughout time, and resurfaced in the 1960s.

The first documented VCA, in 1964 in Equador, was by Roberto Gilbert Elizalde with an attempted hand transplant (Brandacher 2013). At that time, knowledge and understanding of the function of the immune system was limited, the arm was rejected by the recipient’s immune response, and was removed within two weeks of the transplant.

With newly acquired knowledge about the immune system and its response to an organ transplantation, came the development of immunosuppressants. Improvements of immunosuppression in the 1980’s and 1990’s were key to advancing VCA transplantation. The introduction of the key immunosuppressants calcineurin inhibitors, cyclosporine A and tacrolimus, along with the purine analog mycophenolate mofetil, meant that long time graft survival was then possible (Brandacher 2013).
With the usage of modern immunosuppressants, the first successful hand transplant was performed in Lyon, France in 1998 by Dubernard et al. (Cetrulo and Kovach 2013). Following the success of this surgery, came other VCa transplantations ranging from the upper extremities, to the larynx, to the development of partial facial transplantation and full face transplantation.

**Face transplant**

Recipients who receive face donation have suffered from devastating burns, traumatic injuries, or neurofibromatosis. Most recipients have undergone several reconstruction attempts that were unfavorable aesthetically and functionally (Murphy et al. 2013). The use of a facial VCa can help enhance quality of life, and lessen the number of reconstructive surgical procedures that an individual needs to have.

The most extensive facial transplant to date was carried out at the University of Maryland in March 2012, on a patient who suffered from a ballistic trauma. The total face transplantation included reconstruction of the mandible, maxilla, and the tongue (Murphy et al. 2013). One year after transplantation, the patient has regained facial function, sensitivity on the face, and also the sense of smell.

Face allotransplantation is one of the more controversial VCAs procedures. The concept of recovering a donor’s face to be utilized for a transplant is unsettling to some people.

**Lower Extremity**

The loss of a leg is difficult burden to bear. Individuals lose their legs from trauma, infection, and a most from dysvascular conditions such as diabetes mellitus (Carty et al. 2013). Lower extremity VCA is becoming a more considerable option for leg amputees than prosthesis. Lower VCAs are still in its early stages but has had some success in the transplant field.
The first successful lower extremity replantation was performed on a set of ischiopagus twins in 2006 (Carty et al. 2013). The twins were joined at the hip, sharing 3 legs. One faulty leg was shared between the two of them, and each twin also had one functional leg (Fattah et al. 2011). One of the ischipoagus twins was suffering from a lethal cardiac anomaly. With the health of one of the twins fading, emergency separation was decided upon. With the decision of separation came the opportunity to provide the healthy twin with two normal legs (Fattah et al. 2011). The microsurgery was successful and the early results were encouraging. The twin had voluntary movement of the limb along with some sensation (Fattah et al. 2011). With a six year follow up to the procedure the patient had good hip flexion, knee extension, knee flexion, and good toe resistance (Carty et al. 2013).

The success of the first lower extremity replantation gives hope for VCA being an option for lower extremity amputees. In 2010 there was a bilateral above the knee transplantation performed on a 22 year old recipient who lost his legs in a car accident (Cavados et al. 2013). With unsuccessful usage of prosthesis, and a refusal of osseointegrated prosthesis, lower extremity VCA was approved by the hospital and the Spanish National Transplant Organizations (ONT)(Cavados et al. 2013). The transplant went smoothly and a year later the procedure showed very good functional results. The patient performed knee extensions, plantar flexion, and steadily improve walking between parallel bars (Cavados et al. 2013). Even though there is still a lot of skepticism surrounding lower extremity VCA, its future outlook is still bright. Lower extremity (VCa)s, the least supported out of the VCAs, is still considered a reasonable pursuit for leg amputees (Carty et al. 2013).

**Upper extremity**

The most frequently performed VCA procedures so far are those of the hand and upper extremity (Shores et al. 2013). There have been more than 85 patients
around the world who have received upper extremity allotransplantation (Certrulo and Kovach 2013).

An upper extremity procedure exemplifies that VCa is a non-life saving, multi-tissue graft, that is visible. VCa have to have their own special consent from the donor family, separate from solid organ donation. It’s visibility separates it from solid organ grafts because it has to function and be aesthetically pleasing to the recipient. Thus the visible transplant goes through several screening comparing skin color, sex, and size prior to recovery. The most unique characteristic of VCa is that the graft’s nerves can regenerate and restore motor function and sensory nerve innervation. The regeneration of nerves is what make VCAs very desirable compared to prosthetics.

There are two different approaches for recovery of the arm from the donor, “on the table” or the “backtable” method. The “on the table” method, or “in situ”, is when dissections are performed on the donor’s operating table. The “backtable” method, or “cut and run”, is when the arm is removed first, and then surgical dissections are performed on the backtable. Furthermore depending on what is needed for the recipient, there could be a mid-humeral recovery or an elbow disarticulation recovery. The process starts off with an injection of heparin to help with preservation. Then a tourniquet is inflated, and structures are dissected out and tagged. The muscles and nerves are tagged with labels, to avoid subsequent confusion. Reperfusion is performed, and then the arm is removed, and sent to the back table. The back table is a table separate from the patient, where other detailed processes happen. There the arm may be flushed with heparin and preservation fluid, University of Washington (UW) or Histidine tryptophan ketoglutarate (HTK) solution.

Once the arm or hand has been recovered, it will be wrapped and packaged in ice to be transported to the recipient’s operating room. There the arm or hand will be transplanted to the recipient through microsurgery. First the surgeons perform
an osteosynthesis to reconnect the bones. Second is re-vascularization, with the re-
connection of arteries and veins. Third is reattachment of the muscles, tendons, and
nerves, and finally the skin closure is performed (Hartzell et al. 2011).

2. Significance of VCA

Restoration of normalcy and humanity

One of the most important roles of VCA is helping to restore normalcy and
humanity to the recipient. To lose functional ability and to be looked upon as an
outcast from society is very difficult to deal with. For the recipient to regain their
normalcy with an aesthetically pleasing VCa, not only restores their confidence, it
also helps them mentally.

Restoration of the sensation of feeling

The other important characteristic of an upper extremity VCa, and the most
unique, is that it allows the patient to regain function and the sensation of “feeling”.
The “sensation of feeling” is what separates the VCa from a traditional prosthstic.

The grafting of the nerves makes this restoration of feeling possible. The
nerves slowly regenerate over months, and the patients regain both their motor and
sensory innervations. The time needed to complete regeneration depends on how
distal or proximal is the reconstruction. If the transplant is further down the arm
closer to the hand, the nerves will regenerate faster than in a transplant that is more
proximal to arm. Over time, with rehabilitation, motor function is restored and sen-
sitivity is gained.
3. **Organ procurement organizations**

**Purpose**

Organ Procurement Organizations (OPOs) play a pivotal role in organ procurement: they are responsible for the registration of possible donors, and for coordinating the donation process when a donor is available (Organdonor 2014).

The OPO representatives have to follow an established set of guidelines when a donor/transplant candidate is available. They screen the donor to make sure all standards are met. The OPO staff have to first and foremost, get the consent from the family members. Then OPO employees have to check on the donor’s medical history. After medical standards have been met between both donor and recipient, the OPO staff check to see how well the donor arm matches that of the recipient, including consideration of sex, age, and skin tone. Furthermore, the OPO arrange for transportation of the VCa to the recipient’s hospital, either by plane or ambulance (Certrulo and Kovach 2013).

**Number of OPOs in the United States**

There are 58 OPOs across the country, that are regulated by government agencies, and held to the highest medical and ethical standards (AOPO 2011). The OPOs are structured to accommodate their community geographically. For example the New England Organ Bank accommodates Massachusetts, while the Living Legacy Foundation accommodates the state of Maryland.

**Organizational structure of an OPO**

A typical Organ Procurement Organization is structured into several smaller divisions, such as clinical services, hospital development, donor family services, and patient education (AOPO 2011). Clinical services staff ensure that procedures in the hospital are planned and proceed accordingly. Hospital development staff of OPOs
help build the relationship between OPOs and hospitals, and provide education and training techniques to hospital staff (AOPO 2011). Donor family services provide donor families with support and help through their difficult time. For example, if a recipient wants to thank the donor’s family for their loved one’s gift, the Donor Family Services help them connect and express their gratitude. Public education staff brings awareness to the lay public about VCA, and organ donation in general. They also help members of the public recognize that a personal donation or a donation from a family member can save lives.

**Government regulation**

With the arrival of the National Organ Transplant Act (NOTA) in 1984, there was a need for a non-profit, private, and unifying transplant network. In response to NOTA the Organ Procurement Transplantation Network (OPTN) was established (OPTN.transplant.hrsa 2014). Congress created the OPTN to ensure successful and efficient organ transplants across the nation. The OPTN is contracted to the United Network for Organ Sharing (UNOS). Since 1986, UNOS has administered the OPTN and oversees the distribution of organs (UNOS 2014).

In the earlier years of procurement, organ donations were handled regionally. Depending on geographical location and relationships between hospitals, this system worked, but had it limitations (AOPO 2011). With early organ procurements being regional, it was difficult for needy recipients to get organs they required. As the demand for organ donations increased, a national standard was required. The unifying standards now help OPOs nationally to meet their donor/recipients needs.

**Addition of (VCA)s to OPTN as an organ**

On July, 3, 2013, the U.S. Department of Health and Human Services announced that (VCA)s were added to the definition of “organ” covered by the OPTN
and the NOTA (UNOS 2014). With this addition, all individuals involved in (VCA)s are subject to a governing body, which is the OPTN. Some of the requirements from the OPTN are program transplant designation, reporting of data, and to comply with OPTN’s policies and bylaws (UNOS 2014). This unified system provides consistency in VCA's process across the nation.

VCA has become one of the more favorable processes for war amputees. In the year 2012 there was a total of 1,715 amputations from battle injuries, ranging from major to minor limb amputations (Fischer 2013). This alarming number is a big reason why the government gave a big push for (VCA)s to be considered an organ. In 2011 The Honorable Kathleen Sebelius, Secretary of Health and Human Services, received a letter from 17 senators with a portion stating:

“By designating VCA as organs, this existing foundation and infrastructure for allocation, scientific data collection, review and reporting, can be applied more quickly to ensure all individuals, both civilian and military, in need of life altering VCA transplant procedures receive the same consideration as those who receive kidneys and other organs.”

The letter from the senators helped push the ideal for (VCA)s to be added to the organ category. Individuals who suffer from these war injuries can have the opportunity to regain their humanity back faster and through this governed system.

4. Movement in the Operating Room

Coordination of teams of transplant surgeons in the Operating Room

During multiple organ recovery from a donor, there has to be a thorough understanding and coordination amongst teams, and events need to happen in a specific and pre-specified order. For example for solid organs, the procurement sequence is first the heart, second the lungs, and third the liver. Surgeons have to cross clamp the heart and perfuse the donor organs at very specific times to preserve the
precious donation. After perfusion the organ is taken to the "back table" to complete dissecting and the packaging process. Once packaged properly the donation organ is sent to the recipient’s operating room and is ready to be grafted.

The addition of a VCA recovery to the already complex solid organ procurement introduces new challenges. Furthermore, the relatively new process of VCA is still not well known among other transplant surgeons. With (VCa)s being a non-life saving organ, some surgeons look upon it as less important than solid organs.

In a multiple organ recovery, with (VCa) and solid organs, the VCA team informs the solid organ transplant teams of the timing for the procurement of the VCa. With developing, and adhering to, a complex and coordinated work flow in the operating room, efficiency should increase, and trust built between VCA transplant teams and solid organ transplant teams.

The need for synergy

The need for every transplant team to work together is essential in the operating room. Each individual team has to procure their specific organ from the same donor. Certain processes have to occur at specific times when procuring an organ. The synergistic environment has to be achieved so every team can procure a healthy and useful organ for their recipient. For example cross clamping of the aorta has to be agreed upon by all teams. If cross clamping occurs at different times it can compromise the teams’ organ and cause ischemia to set in earlier than desired. Every team is there for the same goal, to be efficient, do effective procurement, and retrieve their organ to save someone’s life or to enhance it.
5. Existing visualizations addressing VCA

There are few illustrations on upper extremity (VCAs). The majority of the literature on VCAs contains very gruesome and graphic pictures of the extremity. There are few anatomical illustrations that are less gruesome, and more illustrations showing the exploded view of arm VCA. Although the illustrations with the exploded views are beautifully rendered in full color, they may be slightly too graphic for some viewers. Aside from its beauty, the exploded view illustrations also point out the important anatomical structures and show some anastomoses and osteosynthesis.

The illustrations that will be created for the guidebook be greater in number and will show some of the important surgical moments in the process. These surgical illustrations along with the guidebook will be the first of its kind.

For multiple solid organ procurement, there are texts on how the flow of the process in the operating room should happen. Current visuals only show the room setup, they do not include VCAs as a part of this setup, or the flow of how the room works. The illustrations for the guidebook shall include VCA’s recovery process in conjunction with multiple solid organ recoveries.

Lack of visuals for OPO employees in guidebook

The Living Legacy Foundation (LLF) of Maryland is developing a illustrated guidebook for upper extremity VCAs. The guidebook will be comprised of text and visuals both contained within a spiral bound book. This guidebook will be designed to train new OPO staff on the processes of screening candidate donors, clinical procedures, and will provide an overview of key steps in the “recovery” surgery. The Living Legacy Foundation of Maryland is compiling the text for guidebook.

Some individuals learn better from visuals than from text, and thus the visuals will be a key component of the guidebook. The more the employees are knowledgeable about VCA procedures, the better they are able to communicate
with each other and with surgeons, and be better equipped to approach donor and recipient families. Also included along with the guidebook shall be a quick reference sheet containing text and illustrations on the choreography in the operating room with multiple organ transplants.

**Lack of visuals to support coordination of VCA and solid organ transplant teams in the OR**

There are few visuals available to give the transplant teams information about the coordination and choreography of the VCA and solid organ teams in the operating room. A quick reference guide is being developed for the Living Legacy Foundation in Baltimore Maryland, to help alleviate some of the anxiety about coordinating procedures that is often created by the addition of a VCA team. It is anticipated that consulting the quick reference guide before and during the procurement process will allow the teams to be better informed about key positions and timing. This guide is also for non-VCA transplant teams and OPO employees. The surgeons from the non-VCA transplant teams could utilize this as a planning tool for their approach in the operating room.

**6. Goals of the thesis project**

A) Create visuals for the OPO guidebook

- **Anatomical review: pen and ink illustrations**

  Anatomical illustrations will help OPO staff to orient to the location of important structures. Showing some of the main structures such as nerves and muscles will help inform OPO employee locations of importance. Knowledge of median, ulnar, and radial nerve will help them direct questions about regeneration of nerves and what muscles are innervated by each. The understanding of muscles location will also help with understanding the surgical moments.
-Surgical moments: pen and ink illustrations

The VCA recovery surgery is very complex, and OPO staff needs to know the process so they can answer questions from donor/recipient families. Illustrations depicting key surgical moments, such as tourniquet application/inflation, vessel dissection, osteotomies, cannulation, and stump closure will be created. These will help bring about a better understanding of the recovery process.

B) Visuals to support coordination of VCA and solid organ transplant teams in the OR

Develop visuals to support a quick reference guides: with icons, limited color

The timing of movements of members of the VCA transplant team and members of the solid organ transplant teams in the operating room are very complex, and coordination and efficiency are required for good outcomes. To address this need, quick reference guides will be developed, and will include an algorithm and visuals showing how the different teams should move about the operating room. These quick guides will help bring about awareness of all transplant teams, and ensure continuity of flow throughout the entire procurement.
MATERIALS AND METHODS

1. Research

Read journal articles, book chapters, and books

To understand the process of VCA, and to devise accurate illustrations of upper extremity VCA surgery, extensive research was necessary. The references helped to clarify the history of VCA, its comparison to solid organ transplant, the pros and cons of the process, and most important for this thesis project - the surgical moments step by step. By cross-referencing the literature sources, the differences of approaches, opinions of surgeons, and the evolution of VCAs, can be appreciated.

Key references were: Brandacher (2013), Carty et al. (2013), Cavados et al. (2013), Certrulo and Kovach (2013), Fattah et al. (2011), Murphy et al. (2013)

Watch Youtube Videos

The website Youtube has streaming videos that can viewed for free. This resource was used to watch videos about the VCA process, and the outcomes of the surgeries. Interviews were watched in which the surgeons explained their procedure for the surgery, and their excitement and optimism for their patient’s outcome. It was interesting to see the patients after the surgery, and to witness the progress made after receiving the VCA surgery. To recognize the patient’s ability to move, and their confidence in the procedure, were key to further understanding the importance of the procedure.

Key Youtube video used in the research for this project were: (youtube. 2010) “Nation’s Third Double Hand Transplant Recipient & Physicians Discuss Progress Part 3 of 6”.
Anatomy review

Anatomy was reviewed to understand the location of the landmarks and structures involved in the recovery process. Of particular importance were neurovasculature, bone structure, and musculature. For example, maintaining the integrity of the three main nerves, radial, ulnar, and median, is essential for nerve regeneration, and muscle motor and sensory innervation.

Key anatomy references were: Eycleshmyer and Schoemaker (1911), Dean and Herbener (2007), Netter (1991), Woodburne (1983).

Meetings with the Living Legacy Foundation, to produce illustrations for their guidebook.

Meetings were held with the OPO, the Living Legacy Foundation of Maryland (LLF), who are developing a guidebook for their staff, for which the thesis illustrations will form a part.

The LLF provided text describing screening protocols, consent and recovery processes, operating room procedural movement, and evaluations (see appendices A and B). The recovery process needed to be illustrated to help OPO staff understand the pivotal moments during the procedure. For example one of the key recovery processes is perfusion, in which the artery is flushed and preserving the VCA. The illustrations are designed to help OPO staff quickly comprehend the concept of each recovery steps.

The LLF also provided information and insight on the organ procurement processes, structure, and technical terms used. For example their terminology avoids such a verb/noun combination as “harvest an arm” because of the harshness of the term. The verb “recovery” is used instead “harvest”, because of its finesse, respect, and sensitivity towards the donor and their family. With respect to donors and their family, the verbage used from the guidebook birthed the idea of simplified, non-
gruesome illustrations.

Meetings with transplant surgeon Dr. Gerald Brandacher to produce illustrations for the guidebook and OR.

Meetings with The Johns Hopkins Hospital transplant surgeon Dr. Gerald Brandacher, Scientific Director of Reconstructive Transplantation, helped clarify surgical processes and information about VCA. Dr. Brandacher’s practical experience was a key source of “insider information” on what the VCA surgical community needs. He spoke of the hectic atmosphere of the operating room, and how some visuals and information could help organization the situation.

Dr. Brandacher presented the problem of confusion between solid organ transplant teams and VCA teams. Organ transplantation is a very time sensitive and precise surgical process. The solid organ transplant teams have their order of recovering organs namely heart, then lung, then liver, which is followed when only solid organ recovery is being undertaken. However, the addition of a VCA transplant team to the operating room requires modification to the procedures followed by the solid organ transplant team.

The development of a quick reference sheet would help orient both solid organ and VCA transplant teams to the coordinated movements they need to follow. Dr. Brandacher identified how this visual could help bring about continuity in the operating room.

Watching a liver transplant in the operating room

A surgery of solid organ recovery of a liver was observed at Howard County General Hospital in Maryland. Even though this procedure was not a VCA recovery, it was still helpful to see the whole process of recovery. Observing the key surgical moments of cross clamping and perfusion gave information needed for development
of the VCA illustrations. To witness the hectic environment when only one organ being recovered gave perspective of how important continuity is within the operating room.

2. Rationalizing of Approach

Explanation of pen and ink

Pen and ink was chosen as the medium in which to create the illustrations. The power of this technique lies in the creation of schematic drawings, with well thought out, and carefully placed lines. When adding shading, different techniques are used to build form. The use of weighted lines in contrast to thinner lines is an example of how to create shadows and form within a pen and ink illustration.

Reasoning for pen and ink usage

Pen and ink was used for the VCA images because of its clarity. The simplified and clear lines of pen and ink makes it attractive to, and highly readable by, the viewer. With clear concise lines, pen and ink directs the viewer through the image, without numerous distracting details, which may impede learning.

Limited color

Limited color was added to the pen and ink illustrations, to orient the viewer, show differences, and establish structures. The vasculature and nerves were colorized, to help show the path of arteries, veins and nerves, and show their significance. Other important elements such as perfusion solution, the tourniquet, and planar transections were also colored to draw attention to their importance.

Once the inking of the images was completed, they were scanned using a Microtek scan-maker, and digitized. The pen and ink images were then manipulated in Photoshop, and selected structures were colorized using the Adobe’s Photoshop
CS6 program. The elements that needed to be colorized were adjusted accordingly with the paint brush feature in Photoshop. For example the vessels were painted red (arteries) or blue (veins), and the nerves were painted with yellow.

3. Developing Images

Taking photo references

Photo references are essential to help with accuracy, and to develop the images for the pen and ink and colorized visuals. Three models posed for photographs of their arms and hands at different angles to help conceptualize depth, angle, and proportion. Photos were also taken of cadaveric arms to get references for the deep anatomy, particularly for tissue depth and location of structures such as the neurovasculature and musculature, that cannot be seen in an intact arm.

Developing sketches

Sketches were developed from literature, videos, operating room sketches from the liver transplant, and photos. Sketch development was key to developing and crystallizing ideas and concepts. Base artwork and inset layouts sketches were presented to content experts, Debbie Mcrann and Karen Kennedy of the LLF, and Dr. Brandacher for feedback and approval for the development of final illustrations.

4. Illustrations for LLF guidebook

Five key steps were selected for illustrations for the LLF guidebook: (i) tourniquet application, (ii) vessel dissection, (iii) possible levels of transection, (iv) perfusion, and (v) prosthetic fitting.

Each of these steps are shown in the two possible scenarios, 1. In Situ and 2. Backtable, in Table 1. There are 2 major differences between the two paths when perfusion is performed. In "In situ" vessel dissection and perfusion is performed
on table, and then the arm is removed. In “Backtable" the arm is removed first and taken to the backtable where perfusion is performed on the removed arm. The flow chart below shows both scenarios with the sequential steps.

Table 1. The two possible scenarios for upper extremity recovery.

<table>
<thead>
<tr>
<th>In Situ</th>
<th>Backtable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tourniquet</td>
<td>Tourniquet</td>
</tr>
<tr>
<td>Vessel dissection</td>
<td>Removal of arm</td>
</tr>
<tr>
<td>In Situ perfusion</td>
<td>Backtable perfusion</td>
</tr>
<tr>
<td>Removal of arm</td>
<td>Stump closure and prosthetic fitting</td>
</tr>
<tr>
<td>Stump closure and prosthetic fitting</td>
<td></td>
</tr>
</tbody>
</table>

i. **Tourniquet application**

The first step of the recovery process in the operating room is tourniquet application. The tourniquet is placed just distal of the insertion of the deltoid or directly over the muscle. The tourniquet is inflated, thus stopping blood flow by constricting vasculature..

Two elements were used: base art of the donor to show tourniquet placement, and cross sections to show how inflation of the tourniquet stops blood flow. The base art of the donor along with vasculature shows the tourniquet in place but not inflated. Once the tourniquet is inflated it shows the pressure produced and the flow of blood ceased. The limited color usage within the artery is faded out to reinforce the stoppage. The cross section physically shows how the vessels are pressurized and stopped to reinforce pressure and blood flow stoppage.
ii. Vessel dissection

The second key step in the recovery process is vessel dissection. A circumferential cut is made distally just below the deltoid insertion to the humerus. Once the cut is completed, important vasculature is identified and dissected, particularly the brachial artery and vein and accompanying veins. After dissection, the vessels are ligated with sutures.

Illustrations were created that focused on the ligation of the brachial artery and vein. Limited color was utilized on the vasculature to draw emphasis to the structures depicted.

iii. Possible levels of transection

There are two different levels of transection when recovering a donor arm. A mid-humeral cut is used for full arm procurement, as needed for a proximally injured recipient. In contrast disarticulation of the elbow, is used for recipients who have more a distal injury.

Both surgical approaches are graphic in nature, and therefore the illustrations had to achieve a balance between conceptualizing to teach, yet be restrained enough to minimize offense.

Base art of the donor was utilized along with two transverse planes at the locations of both cuts. At the planes there are labels stating if it is either a mid-humeral cut or an elbow disarticulation. An arrow from the mid humeral cut plane towards the hand is shown for arm recovery. An arrow from the elbow disarticulation plane towards the hand is for forearm and hand recovery.

iv. Perfusion process

Perfusion is the process of flushing preservation fluid throughout the vasculature. The fluid is released into the brachial artery, and will flow though all the
veins. This important process is a key step to help counter ischemia, which is the restriction of blood supply to tissues.

There are two different scenarios in the perfusion process, “in situ” or “backtable”. “In situ” is performed on the patient while on the table. “Backtable” perfusion is performed once the arm has been removed and sent to the “backtable’ for further processes.

The “in situ” illustration shows the donor arm base art and the brachial artery with the cannula inserted. Limited color was used to show how the preservation fluid is dispensed into the artery. The preservation fluid is shown in a light blue color, and the artery is shown in red, with the shift in color showing the motion of the artery being flushed. The veins are shown being flushed with the preservation fluid coming out of them. The “backtable” illustration starts off with an inset showing forceps opening the artery cannula insertion. Then the removed arm is depicted on a tray with the perfusion lines inserted into the brachial artery being flushed with vein drainage.

v. Prosthetic fitting

Stump closure and prosthetic application is the last step of recovery. The stump is closed so there is no leakage. Once sealed, a prosthetic arm is placed upon the stump, so the donor will not be disfigured and can have an open casket funeral as an option. The illustration shows the stump closed, and being prepared for application of the prosthetic. The prosthetic is placed upon the stump, to restore the integrity of the donor. Arrows and sequential step by step images help visualize this process clearly. The use of limited color shows the closeness of the skin tone matching between the donor arm and the prosthetic.
5. Illustrations for OR, VCA Choreography

There are three possible pathways for VCA recovery in the OR, which involve different movements, or “choreography”, of the VCA transplant team in relation to the thoracic and abdominal solid organ transplant teams. The three pathways for VCA recovery are: 1) prior to solid organ recovery, when perfusion and dissection are carried out on the donor in situ before the solid organ recovery teams work on the donor; 2) post to solid organ recovery, solid organ recovery teams go first, then the VCA team remove the arm and then dissections and perfusion are carried out on the back table and 3) simultaneously with solid organ recovery, when the VCs is prepared simultaneously with the solid organs recovery teams.

The movement interactions between the VCA and solid organ transplant teams were illustrated using three images per pathway, in two formats: for the LLF, each pathway was shown on a separate page, and for the OR all three pathways were shown on one page quick reference guide, thus enabling the three pathways to be easily compared. The illustrations are a “bird’s eye” view of the operating room showing the positions of table setup, patient, solid organ surgeons, VCA surgeons, and OPO employees.

Icons were created to represent different elements within the operating room. The icons were developed with Photoshop and Illustrator to have clean and clear schematic lines. Limited color is used to highlight the VCA surgeon (red), along with other elements such as the perfusion icon (light blue), and OPO employee icon (green). These icons were colored because of their importance, and to emphasize their addition to solid organ transplant teams in the OR. The solid organ transplant team icons were not colored. Arrows were used to help drive the story of choreography from square to square.
6. Constructive criticism and feedback for the preliminary images

Focus group with Living Legacy Foundation

A focus group was held at the Living Legacy Foundation headquarters in Baltimore, Maryland on February 26th 2014. LLF employees that attended consisted of: two family service coordinator, organ recovery coordinator, director of clinical services, clinical manager, senior clinical coordinator, trainer, and a donor service technician of perfusion. With the variety of employees in attendance there were various points of views, levels of comprehension, and skillsets.

Each employee was presented a packet consisting of 6 preliminary black and white images along with an evaluation sheet per image to be filled out. The 6 preliminary images consisted of 1. Tourniquet application, 2. Cuts and Vessel dissection, 3. Perfusion in situ, 4. Perfusion on backtable, 5. Prosthetic application, and 6. Quick reference OR sheet (Figs 2,4,6,8,10,12).

Once the employees flipped through the black and white packet, colored versions of the six images were presented and placed on the table to be evaluated. The employees looked at each colored image and filled out an evaluation sheet per image. The evaluation sheet consisted of 10 questions with each question having a scale from “very much 5” to “not at all 1”, capturing quantitative data (Fig. 1). The scaled questions asked about the quality, effectiveness, and didactism of each image. At the end of each sheet was a comments section, to capture qualitative data, where the individual could leave their constructive criticism.
Evaluation sheet for focus group Feb. 26th 2014

Name ______________________  Position ______________________
Affiliation ______________________  Image # ________

<table>
<thead>
<tr>
<th>Question</th>
<th>Very much</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>Not at all</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. How understandable is the image?</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>2. Does the image help you understand the process?</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>3. Does the use of limited color help direct you to parts of importance?</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>4. Does the use of solid to faded color draw attention to motion?</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>5. Are the anatomical structures accurately illustrated?</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>6. Does the image teach and help you understand the steps?</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>7. How understandable is the labeling?</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>8. Is the amount of labeling sufficient?</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>9. Is the image appropriate (not too graphic) for OPO audience?</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>10. Is the image appropriate (not too graphic) for patient/family members?</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

Comments

Name ______________________  Position ______________________
Affiliation ______________________  Image # ________
Feedback from Dr. Brandacher, Dr. Shores, and UNOS representatives

The 6 colored preliminary images were also presented to Dr. Brandacher for his feedback. He consulted with Dr. Jaimie Shores, one of the founders of the Johns Hopkins University School of Medicine Hand Transplant Program, who also serves as its clinical director. They both inspected each image for the accuracy of terminology, anatomy, and the surgical processes.

Dr. Brandacher also consulted with some of the representatives of the United Network of Organ Sharing with the same 6 colored preliminary images. Dr. Brandacher let the UNOS representatives view the images and give their feedback on effectiveness and whether the images were comprehensible and clear.
RESULTS

1. Overview

The results section presents the initial images, feedback, revision, and final images created for the guidebook and quick reference sheets. First, the quantitative and qualitative data collected from the LLF focus group are presented in a tabulated format. Second, the 6 preliminary images are presented that were evaluated from the Living Legacy Foundation. Third, is the feedback and revision section for the preliminary images, fourth are the final revised images.

2. Focus group results

Quantitative and qualitative data collection from focus group

The evaluation sheets from the focus group were collected and data was developed from that session. Collected data was separated into 2 different data sets, quantitative and qualitative data sets. The combination of these two different data sets shows the effectiveness or ineffectiveness of each image.

The quantitative data was collected from the scaled questions on the evaluation sheet. The number of answers selected for the “5-1” scaled choice answers per question were compiled for each image. Then the number of selected “5-1” answers were added together for each question per image. For example “Image 1 Tourniquet application” received 6 “5s” and 2 “4s” for the first question “How understandable is the image”. This process was carried out for the remaining questions 1-10, and a mean was calculated for each question. For “Image 1” the overall total of “5-1s” was compiled for each number answer. For example “Image 1” “received a total of 55 “5s”, 17 “4s”, 5 “3s”, 1 “2”, and 2 “2s”. This data is important to show statistically if the image is effective or not.
Qualitative data was collected from the same evaluation sheet. At the bottom of the sheet was a comment section where the OPO employee could leave their comments, positive or negative. The feedback was important for image improvement clarification. The qualitative data was an important source of detailed recommendations for revisions.

**Table showing quantitative/qualitative results from focus group**

A table was developed to organize all data collection from the focus group. The first half of the page consists of the quantitative data and calculations of the answers. The second half of the page consists of the qualitative data with quotes from the comment section of the evaluation sheet.

Each image is introduced and followed by a quantitative data table on the first half of the page. The 10 questions from the evaluation sheet are to the left, and the scaled answers “5-1” are separated by vertical columns to the right. There is an extra column next to the scaled answers for the calculated mean, which is provided per question. For each question the number of scaled answers, “5-1”, is counted and then calculated for its mean. Under that is a row of the total number of scaled answers selected “5-1” for the overall image.

The second half of the page, the qualitative data, has each OPO employee by position listed numerically followed by their comment. For example in “Image 1 Tourniquet application” for the first employee the, “Clinical Manager Organ recovery” position is labeled number “1.” followed by a “no comment” because there was no input given on “Image1”. Another example, “2. Family Service Coordinator 1”, left the comment, “Inner arm slice picture very good”, which was represented below the numbered OPO position. This was done for all 8 people that participated in the focus group.
Tables 2-7 depicts both the quantitative and qualitative data explained above. The table consists of 6 pages with data sets presented for images 1-6. The images are 1. Tourniquet application, 2. Vessel dissection/cuts, 3. Perfusion “in situ”, 4. Perfusion on “backtable”, “5. Prosthesis application”, and “6. VCA pathways”.
Table 2. Quantitative/Qualitative data from the focus group, Image 1.

**Evaluation of Image 1 Tourniquet application from Feb. 26th LLF focus group.**

**Quantitative**

<table>
<thead>
<tr>
<th>Image 1 Tourniquet application</th>
<th>Very much</th>
<th>Not at all</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. How understandable is the image?</td>
<td>6</td>
<td>2</td>
<td>4.75</td>
</tr>
<tr>
<td>2. Does the image help you understand the process?</td>
<td>6</td>
<td>2</td>
<td>4.75</td>
</tr>
<tr>
<td>3. Does the use of limited color help direct you to parts of importance?</td>
<td>8</td>
<td>-</td>
<td>5.00</td>
</tr>
<tr>
<td>4. Does the use of solid to faded color draw attention to motion?</td>
<td>5</td>
<td>2</td>
<td>4.50</td>
</tr>
<tr>
<td>5. Are the anatomical structures accurately illustrated?</td>
<td>7</td>
<td>1</td>
<td>4.87</td>
</tr>
<tr>
<td>6. Does the image teach and help you understand the steps?</td>
<td>6</td>
<td>2</td>
<td>4.75</td>
</tr>
<tr>
<td>7. How understandable is the labeling?</td>
<td>6</td>
<td>1</td>
<td>4.62</td>
</tr>
<tr>
<td>8. Is the amount of labeling sufficient?</td>
<td>3</td>
<td>4</td>
<td>4.25</td>
</tr>
<tr>
<td>9. Is the image appropriate (not too graphic) for OPO audience?</td>
<td>5</td>
<td>3</td>
<td>4.62</td>
</tr>
<tr>
<td>10. Is the image appropriate (not too graphic) for patient/family members?</td>
<td>3</td>
<td>2</td>
<td>3.12</td>
</tr>
</tbody>
</table>

Number of possible answers 80  
Actual answers 80  
Total 55 17 5 1 2

**Qualitative**

1. Clinical Manager Organ Recovery- no comment
2. Family Service Coordinator 1  
   "Inner arm slice picture very good"
3. Organ Recovery Coordinator  
   "Instead of brachial a, spell it out  
   -would consider labeling the cross section"
4. Family Services Coordinator 2  
   "Fading color made sense once I read the question about it"  
5. Senior Clinical Coordinator  
   "does fam of donor need to see cross section views- images appropriate for recipients"
6. Trainer  
   "Would follow example of other image and label vasculature a little more  
   -family might find a little too graphic"
7. Donor Services Tech/Perfusion – no comment  
8. Director of Clinical Services  
   "Pressure from tourniquet “B” cut out only a little different “A"
Table 3. Quantitative/Qualitative data from the focus group, Image 2.

Evaluation of Image 2 Vessel dissection/Cuts from Feb. 26th LLF from focus group

**Quantitative**

<table>
<thead>
<tr>
<th>Image 2 Vessel dissection/ Cuts</th>
<th>Very much</th>
<th>Not at all</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. How understandable is the image?</td>
<td>4 3 1 - -</td>
<td>-</td>
<td>4.35</td>
</tr>
<tr>
<td>2. Does the image help you understand the process?</td>
<td>5 2 1 - -</td>
<td>-</td>
<td>4.50</td>
</tr>
<tr>
<td>3. Does the use of limited color help direct you to parts of importance?</td>
<td>7 1 - - -</td>
<td>-</td>
<td>4.87</td>
</tr>
<tr>
<td>4. Does the use of solid to faded color draw attention to motion?</td>
<td>5 1 2 - -</td>
<td>-</td>
<td>4.37</td>
</tr>
<tr>
<td>5. Are the anatomical structures accurately illustrated?</td>
<td>8 - - - -</td>
<td>-</td>
<td>5.00</td>
</tr>
<tr>
<td>6. Does the image teach and help you understand the steps?</td>
<td>7 1 - - -</td>
<td>-</td>
<td>4.87</td>
</tr>
<tr>
<td>7. How understandable is the labeling?</td>
<td>2 6 - - -</td>
<td>-</td>
<td>4.25</td>
</tr>
<tr>
<td>8. Is the amount of labeling sufficient?</td>
<td>5 2 1 - -</td>
<td>-</td>
<td>4.50</td>
</tr>
<tr>
<td>9. Is the image appropriate (not too graphic) for OPO audience?</td>
<td>7 1 - - -</td>
<td>-</td>
<td>4.87</td>
</tr>
<tr>
<td>10. Is the image appropriate (not too graphic) for patient/family members?</td>
<td>3 1 1 - -</td>
<td>3</td>
<td>3.12</td>
</tr>
</tbody>
</table>

Number of possible answers 80  Actual answers 80  Total 53 18 6 0 3

**Qualitative**

1. Clinical Manager Organ Recovery- no comment
2. Family Service Coordinator 1
   - *Definitely keep blue and red for veins and arteries*
   - *Good structure of arm – true to size based on pic*
3. Organ Recovery Coordinator
   - *Would consider removing perfusion bag as there isn’t clear indication of what is being cannulated*
   - *Would spell out vein and keep consistent with labeling of brachial artery.*
   - *Switch 3 with image 2 with 4. On image 3 for better flow of process or show two potential pathways after 2 or image 2 before the cut picture*
4. Family Services Coordinator 2
   - *Take “P” bag tubing off of this image since its not connected*
   - *What does “P” stand for?*
5. Senior Clinical Coordinator- no comment
6. Trainer
   - *Cross section might be too graphic*
7. Donor Services Tech/Perfusion - no comment
8. Director of Clinical Services
   - *Abbreviation for artery and vein – maybe spell it out*
Table 4. Quantitative/Qualitative data from the focus group, Image 3

Evaluation of Image 3 Perfusion “in situ”
from Feb. 26th LLF from focus group

Quantitative

<table>
<thead>
<tr>
<th>Image 3 Perfusion “in situ”</th>
<th>Very much</th>
<th>Not at all</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. How understandable is the image?</td>
<td>6 1 - -</td>
<td>-</td>
<td>4.85</td>
</tr>
<tr>
<td>2. Does the image help you understand the process?</td>
<td>7 1 - -</td>
<td>-</td>
<td>4.87</td>
</tr>
<tr>
<td>3. Does the use of limited color help direct you to parts of importance?</td>
<td>6 1 - -</td>
<td>-</td>
<td>4.85</td>
</tr>
<tr>
<td>4. Does the use of solid to faded color draw attention to motion?</td>
<td>5 3 - -</td>
<td>-</td>
<td>4.62</td>
</tr>
<tr>
<td>5. Are the anatomical structures accurately illustrated?</td>
<td>7 1 - -</td>
<td>-</td>
<td>4.87</td>
</tr>
<tr>
<td>6. Does the image teach and help you understand the steps?</td>
<td>7 1 - -</td>
<td>-</td>
<td>4.87</td>
</tr>
<tr>
<td>7. How understandable is the labeling?</td>
<td>6 1 1 -</td>
<td>-</td>
<td>4.62</td>
</tr>
<tr>
<td>8. Is the amount of labeling sufficient?</td>
<td>7 - 1 -</td>
<td>-</td>
<td>4.75</td>
</tr>
<tr>
<td>9. Is the image appropriate (not too graphic) for OPO audience?</td>
<td>7 - - 1</td>
<td>-</td>
<td>4.50</td>
</tr>
<tr>
<td>10. Is the image appropriate (not too graphic) for patient/family members?</td>
<td>2 1 - 2</td>
<td>2</td>
<td>2.85</td>
</tr>
</tbody>
</table>

Number of possible answers 80  Actual answers 77  Total 60 10 2 2 3

Qualitative

1. Clinical Manager Organ Recovery  
   “3 cuts- helpful image”
2. Family Service Coordinator 1  
   “Can be too graphic for donor families for recipients looks great”
3. Organ Recovery Coordinator- no comment
4. Family Services Coordinator 2  
   “Fading color helps once you understand what it means”
5. Senior Clinical Coordinator  
   “showing different levels of cut for various levels of need for recipient  
   -unsure if graphic appropriate for donor families or for recipients  
   teaching of process”
6. Trainer- no comment  
7. Donor Services Tech/Perfusion -no comment
8. Director of Clinical Services
Table 5. Quantitative/Qualitative data from the focus group, Image 4.

Evaluation of Image 4 Perfusion on “backtable”
from Feb. 26th LLF from focus group

Quantitative

<table>
<thead>
<tr>
<th>Image 4 Perfusion on “backtable”</th>
<th>Very much</th>
<th>Not at all</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. How understandable is the image?</td>
<td>7 6 1 - - -</td>
<td>- - -</td>
<td>5.00</td>
</tr>
<tr>
<td>2. Does the image help you understand the process?</td>
<td>6 1 4 2 -</td>
<td>-</td>
<td>4.85</td>
</tr>
<tr>
<td>3. Does the use of limited color help direct you to parts of importance?</td>
<td>6 1 4 2 -</td>
<td>-</td>
<td>4.85</td>
</tr>
<tr>
<td>4. Does the use of solid to faded color draw attention to motion?</td>
<td>7 - - -</td>
<td>-</td>
<td>5.00</td>
</tr>
<tr>
<td>5. Are the anatomical structures accurately illustrated?</td>
<td>6 1 4 2 -</td>
<td>-</td>
<td>4.85</td>
</tr>
<tr>
<td>6. Does the image teach and help you understand the steps?</td>
<td>6 1 4 2 -</td>
<td>-</td>
<td>4.85</td>
</tr>
<tr>
<td>7. How understandable is the labeling?</td>
<td>5 3 - - -</td>
<td>-</td>
<td>4.62</td>
</tr>
<tr>
<td>8. Is the amount of labeling sufficient?</td>
<td>7 1 - - -</td>
<td>-</td>
<td>4.75</td>
</tr>
<tr>
<td>9. Is the image appropriate (not too graphic) for OPQ audience?</td>
<td>8 - - - -</td>
<td>-</td>
<td>5.00</td>
</tr>
<tr>
<td>10. Is the image appropriate (not too graphic) for patient/family members?</td>
<td>3 - - - -</td>
<td>-</td>
<td>2.85</td>
</tr>
</tbody>
</table>

Number of possible answers 80   Actual answers 77   Total 61 8 0 1 3

Qualitative

1. Clinical Manager Organ Recovery- no comment
2. Family Service Coordinator 1
   “Love the use of light color to show perfusion in arm”
3. Organ Recovery Coordinator
   “The brachial artery should be a lighter red rather than darker red which = perfusion”
4. Family Services Coordinator 2- no comment
5. Senior Clinical Coordinator
   “Image good for recipient teaching/ OPO but unsure about donor family”
6. Trainer- no comment
7. Donor Services Tech/Perfusion -no comment
8. Director of Clinical Services
   “same abbreviations, spell out artery”
Table 6. Quantitative/Qualitative data from the focus group, Image 5.

Evaluation of Image 5 Prosthesis application from Feb. 26th LLF from focus group

Quantitative

<table>
<thead>
<tr>
<th>Image 5 Prosthesis application</th>
<th>Very much</th>
<th>Not at all</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5 4 3 2 1</td>
<td></td>
</tr>
<tr>
<td>1. How understandable is the image?</td>
<td>7 1 - - -</td>
<td>4.75</td>
</tr>
<tr>
<td>2. Does the image help you understand the process?</td>
<td>7 1 - - -</td>
<td>4.75</td>
</tr>
<tr>
<td>3. Does the use of limited color help direct you to parts of importance?</td>
<td>7 1 - - -</td>
<td>4.75</td>
</tr>
<tr>
<td>4. Does the use of solid to faded color draw attention to motion?</td>
<td>5 1 - - -</td>
<td>4.80</td>
</tr>
<tr>
<td>5. Are the anatomical structures accurately illustrated?</td>
<td>7 - - - -</td>
<td>5.00</td>
</tr>
<tr>
<td>6. Does the image teach and help you understand the steps?</td>
<td>7 - - - -</td>
<td>5.00</td>
</tr>
<tr>
<td>7. How understandable is the labeling?</td>
<td>7 - - - -</td>
<td>5.00</td>
</tr>
<tr>
<td>8. Is the amount of labeling sufficient?</td>
<td>7 - - - -</td>
<td>5.00</td>
</tr>
<tr>
<td>9. Is the image appropriate (not too graphic) for OPO audience?</td>
<td>8 - - - -</td>
<td>5.00</td>
</tr>
<tr>
<td>10. Is the image appropriate (not too graphic) for patient/family members?</td>
<td>3 - 1 - -</td>
<td>2.75</td>
</tr>
</tbody>
</table>

Number of possible answers 80  Actual answers 74

| Total | 65 4 1 0 4 |

Qualitative

1. Clinical Manager Organ Recovery- no comment
2. Family Service Coordinator 1
   “Like the difference in arm and prosthesis color
   -fsc- color the stump a color”
3. Organ Recovery Coordinator- no comment
4. Family Services Coordinator 2- no comment
5. Senior Clinical Coordinator- no comment
6. Trainer
   “why the word “water”? is that commonly used to describe closure”
7. Donor Services Tech/Perfusion -no comment
8. Director of Clinical Services
   “not sure about water tight”
Table 7. Quantitative/Qualitative data from the focus group, Image 6.

Evaluation of Image 6 VCA Pathways from Feb. 26th LLF from focus group

**Quantitative**

<table>
<thead>
<tr>
<th>Image 6 VCA Pathways</th>
<th>Very much</th>
<th>Not at all</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. How understandable is the image?</td>
<td>3</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>2. Does the image help you understand the process?</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3. Does the use of limited color help direct you to parts of importance?</td>
<td>6</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>4. Does the use of solid to faded color draw attention to motion?</td>
<td>3</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>5. Are the anatomical structures accurately illustrated?</td>
<td>5</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>6. Does the image teach and help you understand the steps?</td>
<td>4</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>7. How understandable is the labeling?</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>8. Is the amount of labeling sufficient?</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>9. Is the image appropriate (not too graphic) for OPO audience?</td>
<td>8</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>10. Is the image appropriate (not too graphic) for patient/family members?</td>
<td>1</td>
<td>1</td>
<td>-</td>
</tr>
</tbody>
</table>

Number of possible answers 80 Actual answers 72

| Total | 37 | 15 | 9 | 6 | 5 |

**Qualitative**

1. Clinical Manager Organ Recovery - no comment
2. Family Service Coordinator 1
   
   “- Really like that only the VCA recovery man is highlighted
   -small mention of pt still on the vent
   -mention for brain death donation only
   -for some families will always be too graphic”
3. Organ Recovery Coordinator-
   ‘What is the emphasis of the “P” and the various locations in each image-
   importance not conveyed clearly
   -group in situ vs. backtable perfusion pictures”
4. Family Services Coordinator 2
   “What does the “P” stand for
   -Is the person in the red the VCA surgeon?
5. Senior Clinical Coordinator
   “need a key: who is who for images
   -add brain death to type of recovery
   -would not include this image for donor or recipient fam/patient
Table 7. Quantitative/Qualitative data from the focus group, Image 6.

Evaluation of Image 6 VCA Pathways from Feb. 26th LLF from focus group

**Qualitative cont.**

6. Trainer

- wording on middle image-delete “to” to read post solid organ recovery
- wording on lower image-change to “simultaneous”
- need legend to define who the people are
- may benefit from some flow type arrows to assist to show motion
+ sequence within each category
- “I know you want to consolidate each pathway on one page but it might be worth separate pages to maximize teaching opportunity we usually know before the OR which path is being used, so you could then pull the pathway sheet (each one as a separate page) + focus the teaching there”

7. Donor Services Tech/Perfusion - no comment

8. Director of Clinical Services

“Label each: Pathway A
            Pathway B
            Pathway C”

---

**3. Feedback and Revisions**

This section shows the feedback and revision suggestions from the LLF focus group, Dr. Brandacher, Dr. Shores, and UNOS representatives. First the subject is presented followed by the feedback and revision suggestions from the LLF focus group. Second the preliminary image is shown that was presented at that focus group and to Dr. Brandacher, Dr. Shores, and UNOS representatives. Third is the feedback from Dr. Brandacher, Dr. Shores, and UNOS representatives, followed by all of their revision suggestions. Lastly the finalized image is presented showing the revisions made.
- **Tourniquet application**

- **Feedback from LLF focus group (Fig. 2)**

  Critical feedback was targeted towards labeling, appropriateness for donor family, color usage, and the difference between two images showing action. (a) It was stated that the “brachial a.” label should be spelled out as “brachial artery”. (b) The color fade within the brachial artery wasn’t as clear, and needed to have more of a fade to show blood flow stoppage. (c) There was a suggestion for more structural labels on the cross sections. (d) The first cross section’s inset showing the brachial artery with blood flow was considered to be too similar to the second cross section showing the brachial artery being compressed.

- **Revisions (Fig. 3)**

  (a) The “brachial a.” was changed to “brachial artery”. (b) The color fade within the brachial artery was adjusted to emphasize the fade and make it more clearly visible. (c) More labels were not added to the cross sections because they were only supporting images to the main image, which focused on the donor patient. (d) There was more attention to detail when showing differences between the two insets of the cross sections. The inset with the brachial artery blood flow was shown with a clear open vessel filled with flat red color. The second inset showing brachial artery blood flow stoppage has edges nearly touching with faded red color, to reinforce compression.
Fig 2. Preliminary Image 1, Tourniquet application from Focus Group.
-Feedback from Dr. Brandacher and UNOS representative (Fig 2.)

Critical feedback was targeted towards technical placement of tourniquet, anatomical corrections, and design hierarchy. (a) The tourniquet has two different locations of placement, and the single image only showed the deltoid insertion placement. (b) It was suggested that another set of illustrations be added to show the two different setups of tourniquet placement. (c) The tourniquet in the original main image should be moved above and proximal to the deltoid muscle. It was also suggested to add another illustration showing the lower deltoid insertion placement of the tourniquet. (d) The cross sections of the humerus and neurovascular compartment had inaccuracies, and the location and size of the cross sections were considered to be too large.

-Revisions (Fig. 3)

(b) There were two illustrations added showing the different setups for the tourniquet. (a) The first setup depicts the corrected distal deltoid insertion, and the second the above and proximal deltoid muscle setup. (c) In the main image the tourniquet was moved more proximally over the deltoid muscle. (d) The cross sections were revised with a larger, more medial humerus depicted. The neurovascular compartment was also raised. Both cross sections were reduced in size to draw less attention, and draw the focus to the main image which was the donor.
Fig 3. Revised Image 1, Tourniquet application

1. Tourniquet application
   A. Placement

   ![Tourniquet Options](image)

B. Tourniquet inflation

   ![Tourniquet Inflation](image)
-ii Cuts and Vessel dissection

-Feedback from LLF focus group (Fig. 4)

(a) The perfusion bag in image 2 was considered out of place and should not be introduced yet. (b) The image was unclear with the combination of the “2. Vessel dissection” illustration along with the “3. Cuts” illustration. It was unclear when the vessel dissection happens in relation with the cuts of the arm.

-Revisions (Fig. 5)

(a) The perfusion bag was removed to resolve the problem of it being introduced to soon. (b) To address the issue with the chronological order of the processes, “2. Vessel dissection” was removed from this page. The “3. Cuts” illustration remained on the second image page.
Fig 4. Preliminary Image 2, Vessel dissection/ cuts from Focus Group.
Feedback from Dr. Brandacher and UNOS representative (Fig 4.)

(a) The cross section was considered too large and needed to be reduced compared to the main image. (b) The “2. Vessel dissection” was sequentially out of order. This process can only be performed only in situ and the combination of illustration “2. Vessel dissection” with illustration “3. Cuts” was confusing. (c) The perfusion bag needed to be removed because of its misorder.

Revisions (Fig. 5)

(b) To resolve the confusion of the processes in “image 2” illustrations were renamed. “2. Vessel dissection” was renamed to “3. Recovery, In situ recovery vessel dissection” to specify when the process happens. (a) The cross section was reduced in size to keep emphasis on the main image. “3. Cuts” became the main image and was renamed “2. Possible levels of transections”. With the switch of these two images it made it easier to follow the steps. (c) The perfusion bag was removed because it should not be shown at this time.
Fig 5. Revised Image 2 Possible levels of transection/ recovery

2. Possible levels of transsection

3. Recovery

A. In “Situ” Recovery vessel dissection
-iii Perfusion in situ

-Feedback from LLF focus group (Fig. 6)

(a) The fading color of the perfusion solution was considered not fading out enough in the brachial artery in the illustration. The brachial artery needed to fade more from red to light blue to show the perfusion process clearly. (b) It was suggested to spell out “artery” and “vein” and consistently do so throughout all illustrations for continuity.

-Revisions (Fig. 7)

(a) To clarify the perfusion solution flow into the brachial artery, the fading color was emphasized by having less red in the artery and showing light blue flowing throughout the artery. (b) Instead of “brachial a.”, artery was spelled out to maintain continuity throughout the images.
Fig 6. Preliminary Image 3, Perfusion in “Situ” from Focus Group.
-Feedback from Dr. Brandacher, Dr. Shores, and UNOS representative  (Fig. 6)

(a) The insertion of the cannula into the artery was not depicted properly. The brachial artery is not cut to a stump, but is incised with a slit. Since the artery is not divided it does not bend while the cannula is inserted. (b) The cannula is inserted parallel not perpendicular into the artery. (c) The tourniquet was too close to the area of perfusion and needed to be moved proximally over the deltid muscle more. (d) Veins needed to be shown to show where the perfusion solution is released from the vascular system in the arm.

-Revisions (Fig. 7)

(a) The brachial artery was turned from a divided stump back to an image of a full artery with an incision down the middle of it. (b) The cannula’s angle of insertion was changed to be more parallel to the artery instead of perpendicular. (c) The tourniquet placement was moved proximally toward the deltoid muscle away from the perfusion site. (d) The cephalic and basilic veins were added to show solution drainage. Arrows were also added throughout the arteries and veins to clarify the direction of flow.
Fig 7. Revised Image 3, Recovery “in situ”
-iv Perfusion on backtable

-Feedback from LLF focus group (Fig. 8)

(a) The brachial artery’s red color needed to be lightened to depict the flow of perfusion solution throughout the artery. (b) The fade needed to be clearer to show the perfusion process taking place.

-Revisions (Fig. 9)

(a) The brachial artery’s red color was lightened to show the perfusion solution flowing throughout the artery. (b) More light blue was added throughout the artery to make the perfusion process more distinct.
Fig 8. Preliminary Image 4, perfusion on backtable from Focus Group.

4. Perfusion on “Backtable”
-Feedback from Dr. Brandacher, Dr. Shores and UNOS representative (Fig. 8)

(a) Additional illustrations were suggested to help the flow of the processes for backtable perfusion. The arm for the backtable needed to be placed on a tray instead of being a free-floating image on the page. (b) The cannula needed to be shown inserted and tied into the brachial artery stump slightly protruding from the arm. (c) Venous drainage also needed to be added to this illustration depicting the perfusion solution removing the blood.

- Revisions (Fig. 9)

(a) To help clarify the process new illustrations were added. The first illustration is an inset of the cross section of the neurovascular bundle depicting the cannula insertion. The second illustration was another arm with a perfusion bag. (b) Both arm illustrations showed brachial arteries tied off with a cannula. Trays were also added to both illustrations to show the perfusion solution being drained into the tray. (c) Perfusion color was added to the veins in the cross section cut of both arms to explain the drainage.
Fig 9. Revised Image 4, Recovery “backtable”

Upper Extremity VCA

3. Recovery

B. “Backtable”

- Brachial artery
- Cannula insertion
- Forceps

- Brachial artery with cannula inserted
- Perfusion solution
- Cephalic vein drainage
- Brachial artery flushed

© James Abraham
-v Prosthesis application

-Feedback from LLF focus group (Fig 10.)

(a) The prosthesis illustration was clear, the label “water tight closure” was questioned.

-Revisions (Fig 11.)

(a) The label “water tight closure” is an actual term used for closing the donor stump, so it was not changed.
Fig 10. Preliminary Image 5, prosthesis application from Focus Group

Upper Extremity VCA

5. Prosthesis application

Water tight closure

Prosthesis

Close skin tone match

© James Abraham
-Feedback from Dr. Brandacher, Dr. Shores and UNOS representative (Fig 10.)

(a) The title “Prosthesis application” needed to be changed to “Prosthesis fitting”. It was also necessary to add an elastomer sleeve on the prosthesis to be slipped over the top of the donors stump.

- Revisions (Fig 11.)

(a) The title was changed to “Prosthesis fitting” and the elastomer sleeve was added to the prosthesis.
Fig 11. Revised Image 5, Prosthetic fitting

Upper Extremity VCA

4. Prosthesis fitting

Water tight closure

Sleeve

Prosthesis

Close skin tone match

Sleeve rolls over arm

© James Abraham
-vi VCA Pathways

-Feedback from LLF focus group (Fig 12.)

(a) There needed to be a colored key to identify the icons within each step of the pathway. (b) Arrows are needed to help show flow and movement between the different teams. (c) An addition of an OPO employee icon was suggested to help show their location and importance of their role. (d) There needed to be an explanation of what the circled “P” stood for. (e) The pathways were too under represented, and each pathway needed its own page to give a better representation of each pathway’s key steps.

-Revisions (Fig 13.-16.)

(a) A colored key was added to supplement the icons and give distinction between all the icons. (b) Arrows were added to help show movement of steps and flow of choreography within the OR. (c) An OPO employee was added and colored green to be recognized as a significant element within the OR. (d) The addition of the key also solved the problem of the circled “P” which is labeled as perfusion in the key. (e) Three more illustrations were developed for each different pathway. There was a page for Pathway A, a page for Pathway B, and a page for Pathway C, which brings the VCA pathways illustrations to a total of 4 images.
Fig 12. Preliminary Image 6, VCA Pathways from Focus Group
- Feedback from Dr. Brandacher, Dr. Shores and UNOS representative (Fig 12.)

(a) There needed to be an addition of a key and another VCA surgeon for every step. (b) In “Post to solid organ recovery”, “Pathway B”, the arm table for the donor needed to be extended throughout all the images.

- Revisions (Fig 13.-16.)

(a) A colored key was added to help distinguish each icon from one another. Another VCA surgeon was added so that there was a total of 2 VCA surgeons per step. (b) The table for the donor’s arm was extended outward in the ready position for VCA surgery throughout all the images.
VCA Pathways

Pathway A prior to solid organ recovery

Key
- VCA team
- Perfusion
- Solid organ team
- Prosthesis
- OPO team
Fig 14. Revised Image 6, VCA Pathways, Pathway B
Fig 15. Revised Image 6, VCA Pathways, Pathway C

VCA Pathways

Pathway C simultaneously solid organ recovery

Key
- VCA team
- Perfusion
- Solid organ team
- Prosthesis
- OPO team

© James Abraham
Asset Referal Page

Access to the guidebook resulting from this thesis can be obtained by contacting James Abraham at abrahamart@hotmail.com. The author may also be reached through the Department of Art as Applied to Medicine via website www.hopkinsmedicine.org/medart.
DISCUSSION

1. Synthesis and critique of the thesis project

The goal for this thesis was to produce effective, didactic illustrations for the Living Legacy Foundation's guidebook. This project needed teachable illustrations that would not offend the viewers, data supporting the effectiveness of each image, and also feedback from viewers with various transplant surgery backgrounds. The focus group held at the LLF’s headquarters was an excellent way to receive feedback and develop statistical data. The goal of the focus group was to see if the illustrations were readable and effective. All the images scored very highly except for the (vi) VCA Pathways. Changes were made to all the images in response to the qualitative feedback from the LLF focus group, amd from Dr. Brandacher, Dr. Shores, and UNOS representatives.

The strengths from this project were the use of pen and ink with limited color, having a focus group with evaluation sheets, and having pivotal feedback from Dr. Brandacher and Dr. Shores. The pen and ink usage with limited color was highly effective, and made the illustrations a clear and concise teaching implement. The focus group feedback with the evaluation sheets was a good way to measure the effectiveness of the images and develop data sets from each sheet. That data collected from that focus group supported the usage of pen and ink with limited color as being a very effective medium for the images.

The feedback from Dr. Brandacher and Dr. Shores added to the strength of the thesis with their expertise in reconstructive transplant surgery. It was very important that the images were accurate. Dr. Brandacher and Dr. Shores both analyzed each image for anatomical and surgical procedural correctness. The combination of their feedback with the LLF helped the images be accurate and very effective visually.
There was only one weakness in this project found in the evaluation sheet, question number 10. It states: “Is the image appropriate (not too graphic) for patient/family member?”. The question was confusing because there are two different families involved, the donor’s family and the recipient’s family. The question on the evaluation sheet did not specify which family, and that is what led to some mixed answers for question 10 on the qualitative data. Some people felt the illustration was ok for the recipients family, but not for the donor’s family. The same question should have been asked twice referring to the two different families, donor/recipient.

2. Recommendations for successful illustrations for a VCA guidebook
   - pen and ink usage
   - limited color usage
   - design for a specific audience
   - non-graphic appropriate illustrations
   - use language specific to OPO’s and transplant teams
   - have focus groups
   - get feedback from specialists on the subject

3. Disseminations of illustrations
   Living Legacy Foundation and other organizations usage

   Upon completion, the guidebook containing visuals newly created during this thesis project, and text written by the LLF, will be distributed to employees of the Living Legacy Foundation in Maryland. If successful amongst the LLF employees, the guidebook will be distributed to other local Organ Procurement Organizations. The first level of distribution will be regional, to: Washington Regional Transplant Con-
sortium of Washington D.C., Center for Organ Recovery and Education at the University of Pittsburgh, and Gift of Life Donor Program of Philadelphia.

**Present to United Network of Organ Sharing (UNOS)**

The guidebook will be presented to the UNOS committee. If the guidebook is accepted, UNOS has the opportunity to recommend that this guidebook be distributed nationwide to all OPOs and transplant centers.

**Present to the American Society of Reconstructive Transplantation**

The guidebook will also be provided to the American Society of Reconstructive Transplantation (ASRT). The ASRT provides the most up to date information and education on reconstructive surgery, which includes VCA. The ASRT will be able to post the guidebook on their website, where the guidebook can serve as an educational resource on upper extremity VCA.

**Guidebook could set national standards**

The guidebook could also serve as a model for national best practices for illustration of the hand and upper extremity donation processes. The guidebook could set the standard for OPOs nationwide, and help with the continuity of the process and continue to enlighten OPOs and non-VCA transplant teams.

**4. Future directions**

**Develop guidebook for other VCA structures (face/ lower extremity)**

If the upper extremity guidebook is successful, more guidebooks could be developed for other VCA structures, and could serve as a template for the other VCAs. Each guidebook shall have similar principles but address different anatomical locations. There could be guidebooks for the face, lower extremity, larynx and other
(VCa)s. Guidebooks like this one could serve as an educating tool, and set national, unified standards for all OPOs and transplant teams.
Cited References


General References


Appendix A- Operating room procedures for VCA recovery

Planning for the Recovery Surgery
A. Many factors influence set-up of Operating Room for VCA recovery. Those factors include:
   - Number of organs being recovered
   - Sequencing of when VCA graft will be recovered: prior to, simultaneous to, or after solid organ recovery
   - Number of transplant, donor hospital, and organ procurement organization team members who will be present
B. Communication is essential in planning for surgical recovery process
   - OPO team huddles with VCA team to discuss recovery plan
   - Once recovery plan established, OPO and VCA team huddle with donor hospital staff to work through logistics of OR set up
   - Solid organ recovery teams are notified prior to recovery that surgical recovery will include VCA graft(s)
   - Once solid organ teams on-site, all parties huddle to discuss recovery planning and logistics, especially for timing of VCA graft recovery

Operating Room Set-Up and Donor Positioning
A. During room set-up, provisions are made to provide the solid organ and VCA teams with
   back table areas for post recovery evaluation, flushing and packaging of the grafts
B. When donor is brought into the OR, arm(s) which will be recovered are positioned with arm
   boards projecting out at a 90 degree angle to table, rather than tucked parallel to torso as is
   standard in solid organ recovery
C. Arm(s) are prepped and draped in same manner as for solid organ recovery
D. Level of disarticulation is determined by extent of graft needed for targeted recipient
E. Placement and positioning of recovery teams at OR table is determined during huddle
F. VCA team and OPO coordinate, prior to recovery, to ensure all needed supplies are brought
   to OR; OPO oversees which items are supplied by OPO and which are provided by donor
   hospital; supplies include:
      - Flush, cannulas, packaging and labeling supplies
      - Tourniquet, prosthetics, and Versajet machine for vertebral body recovery

Timing and Logistics of Graft Recovery
A. Graft recovery prior to solid organ cross-clamp and recovery
   - VCA recovery surgeons place a tourniquet on arm(s) to be recovered
   - If this is a bilateral arm recovery, recovery of both limbs performed simultaneously
   - Graft(s) are disarticulated and taken to back table for flush, anatomy documentation,
     and packaging and labeling, while another member of VCA team closes graft site on
     donor
   - Solid organ recovery commences once graft(s) recovered, per usual practices
   - Prosthetic(s) placed and vertebral bodies recovered after solid organ recovery complete
B. Graft recovery simultaneous to solid organ recovery
   - Surgical teams are positioned at table according to plan established during huddle
Appendix A cont.

- Timing of cross-clamp determined in collaboration with all surgeons gathered at table for recovery; VCA team inserts cannula for VCA graft perfusion
- If bilateral arm recovery, recovery of both limbs performed simultaneously
- VCA graft(s) recovered post cross-clamp, in coordination with solid organ teams, and taken to back table for flush, anatomy documentation, and packaging and labeling
- VCA team closes graft site, places prosthetic and recovers vertebral bodies post cross-clamp

C. Graft recovery post cross clamp for solid organ recovery
- Timing of cross-clamp determined in collaboration with all surgeons gathered at table for recovery; VCA team inserts cannula for VCA graft perfusion
- After cross-clamp occurs for the solid organ recovery, VCA team moves to the OR table to recover graft(s)
- If bilateral arm recovery, recovery of both limbs performed simultaneously
- Graft(s) taken to back table for flush, anatomy documentation, and packaging and labeling
- VCA team closes graft site, places prosthetic and recovers vertebral bodies, post cross-clamp
Appendix B- Guide for VCA hand evaluation/acceptance/recovery

Guide for VCA hand evaluation/acceptance/recovery:

Primary Screening:
- Age/Sex/Race, ABO, Ht/Wt
- Cause of death
- Public Health Service increased risk criteria screen
- Time constraints of the family
- Physical exam results
- Time serology & HLA results are expected
- Photos of the donor’s arm palm down & palm up from fingertip to shoulder. More than one image can be sent. It can also be helpful to send a photo of a person with a similar ht/wt of the intended recipient next to the donor’s arm for comparison
- Measurements of hand if requested
- The photo of the arm should be the same arm that the recipient is in need of

Secondary Screening:
- Serology/HLA results
- Medical/social history review
- Clinical status/labs/meds
- VCA hand consent discussion plan
- Crossmatch plan with OPO (pre or post consent)
- Consent discussion with family

Post Consent:
- Document verification of ABO for recipient and donor
- Remove aline, piv from intended extremity as soon as possible
- Review case with medical examiner, coroner and/or funeral home
- A/P and lateral radiographic images of intended donor extremity, images sent to VCA transplant team
- OPO operating room coordination with solid organ teams, donor hospital, VCA transplant team
- Verify plan for VCA recovery supplies and packaging
- Credential verification documented in OPO record for recovery surgeon
- 2 transportation set up
  - VCA hand recovery team (return with VCA graft immediately after recovery)
  - VCA vertebal recovery or reconstruction team (donor reconstruction and VB recovery post solid organ, before tissue recovery)
- Pack supplies for hand and vertebral body recovery, perfusion solution, packaging and labeling supplies, prosthetics for internal and external donor reconstruction

Post Recovery:
- Culture follow up, report positives to VCA hand team
- Recipient outcome/graft status

Contact Information:
- Primary OPO contact:
- Primary/Secondary VCA surgeon contact:
- Primary/Secondary VCA transplant coordinator contact:
VITA

James Alexander Abraham was born and raised in Richmond, Va. As a child, James loved sports, comic books, video games, movies, and art. His fascination with those things at an early age developed him into a well-rounded, artist-athlete. The combination of sports and art both shared a common theme, which was discipline and hard work, and helped James to develop his work ethic and drive at an early age. As he would flip through magazines and comic books he noticed that the figures he was copying were drawn with distinct structures. This was his first lesson in anatomy. His parents, Rita and Isaac Abraham, supported his inquisitiveness with supplies and books to help him blossom into a young artist.

James attended Hermitage High School in Richmond, VA, where he graduated with honors, artistically, academically, and athletically. After graduation he attended Virginia Commonwealth University, where he was classically trained in fine arts and also participated on the VCU’s men Track and Field team. He received his Bachelors of Fine Arts from in 2005. He continued his education taking science courses in pursuit of going to graduate school for medical illustration. With his passion for art and love for science, biomedical illustration was a perfect match for him.

In 2012 he was accepted into The Johns Hopkins University School of Medicine’s Art as Applied to Medicine graduate program. There he was trained to become a biomedical illustrator. While attending Johns Hopkins, James received the Chester E. Reather scholarship and also the Dean’s scholarship. He will receive his Master of Arts degree in Medical and Biological Illustration in May of 2014.