

**Comparison of video education and traditional genetic counseling for  
pancreatic cancer: Assessment of patient satisfaction and knowledge**

by

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University of Pittsburgh, 2021

### **Abstract**

The American Cancer Society estimates that in 2021 60,430 individuals will be diagnosed with pancreatic cancer and 48,220 individuals will die from the cancer. Pancreatic ductal adenocarcinoma (PDAC) has a 5-year survival rate of 9% largely due to the typical detection at an advanced stage. Initiatives in the field of oncology have focused on the importance of detection of cancer at an early stage. Genetics plays a role in early detection through the identification of a genetic predisposition to cancer. Approximately 10% of PDAC diagnoses are due to a germline pathogenic variant. Identification of a pathogenic variant can have implications for both the patient and their family members. PDAC is part of several hereditary cancer predisposition syndromes and genes that cause increased risk for multiple cancer types and have specific guidelines to increase early detection or reduce the risk for some cancers. Pathogenic variants in certain genes are compatible with precision therapies that can aid in treatment of PDAC.

The National Comprehensive Cancer Network (NCCN) and American Society for Clinical Oncology (ASCO) recommend that all individuals with PDAC have a genetic evaluation and consider germline genetic testing. Ideally, this should be done by a genetic counselor who specializes in cancer genetic counseling. However, there continues to be a nationwide shortage of genetic counselors. This has led to development of alternative service delivery methods.

University of Pittsburgh Medical Center (UPMC) created a short educational video about the genetics of pancreatic cancer in effort to increase access to germline genetic testing. This study

aimed to assess the effectiveness and patient satisfaction of this delivery method of genetic information. Two delivery methods were compared; video education and traditional in-person genetic counseling for individuals diagnosed with PDAC. Genetic literacy was evaluated prior to education and knowledge and satisfaction were assessed immediately following the genetics education. For individuals who pursued genetic testing, knowledge was assessed at an additional timepoint.

While this study focuses on genetic counseling, these research findings are relevant to the field of public health as it could provide baseline information advising the use of video education in a variety of settings.

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## Preface

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## 1.0 Introduction

The goal of this study was to build upon a previous pilot study which evaluated the use of video education for individuals with pancreatic ductal adenocarcinoma (PDAC). The pilot study evaluated pancreatic cancer knowledge between a group who received traditional genetic counseling and a group who watched an educational video. This study was continued with the additional evaluation component of patient satisfaction with each delivery method.

Pancreatic ductal adenocarcinoma is an aggressive cancer with poor early detection. Approximately 10% of individuals with pancreatic cancer harbor a pathogenic variant in a pancreatic cancer susceptibility gene.<sup>1</sup> Identification of a pathogenic variant can have implications for oncologic treatment and for family members of an affected individual. The American Society of Clinical Oncology (ASCO) and National Comprehensive Cancer Network (NCCN) recommend that all individuals with pancreatic cancer undergo risk assessment for a hereditary predisposition to cancer.<sup>2,3</sup> This recommendation can be difficult to fulfill as there is a shortage of genetic counselors available who can provide counseling for pancreatic cancer in a short time frame that adapts to the limited survival rate of PDAC and need of information for potential treatment implications.<sup>4</sup> The barrier to genetic evaluation highlights the need to explore alternative methods of service delivery.

University of Pittsburgh Medical Center (UPMC) created a multidisciplinary clinic (MDC) for individuals newly diagnosed with pancreatic cancer through which they can meet with all necessary specialists in one appointment. This structure includes a genetics consultation and subsequent research-based evaluation of delivery methods. The UPMC MDC takes place in two medical centers, Hillman Cancer Center and Presbyterian Hospital. A 5-minute video explaining

the genetics related to pancreatic cancer and genetic testing was developed as an alternative method of delivering genetics education.

The pilot study which began in January 2020 was continued as a comparison of participant genetic knowledge between a group who received traditional genetic counseling with an in-person certified genetic counselor and a group who watched the educational video. **The specific aim of this study was to determine if the use of video education is a practical and effective way to deliver information about genetic testing for individuals with pancreatic ductal adenocarcinoma.**

An additional aim which began in September 2020, was implemented as a comparison of patient satisfaction with their designated method of receiving genetic education about pancreatic cancer. **The specific aim of this study was to assess patient satisfaction with receiving genetics education about pancreatic cancer and genetic testing through video education.**

These aims were evaluated through administration of questionnaires to patients in-person during their MDC appointment before and after receiving genetics education, and then at an additional timepoint for follow-up. The overall goal of this study was to examine the use of pre-recorded video education material to evaluate the effectiveness and satisfaction of this method of providing genetic information. While this study focused on genetic counseling for pancreatic cancer, these research findings are relevant to the overall field of genetic counseling. Findings from this study could provide information pertaining to the use of video education as an effective and satisfactory method of genetic information delivery in other cancer genetic counseling settings in the future.

## **2.0 Literature Review**

### **2.1 Pancreatic Cancer**

Pancreatic cancer is considered a rare and aggressive form of cancer. In 2018, there were 458,918 reported cases of pancreatic cancer globally, and 432,242 deaths.<sup>1</sup> While the United States has made significant advancements in the treatment and management of cancer, pancreatic cancer remains the third most common cause of cancer-related deaths in the United States, with a 5-year survival rate of 9%.<sup>1</sup> The annual report from the American Cancer Society estimates that in 2021, 60,430 individuals will be diagnosed with pancreatic cancer and that 48,220 deaths will occur as a result of the cancer.<sup>5</sup>

One of the reasons for the high mortality rate of pancreatic cancer is the limited options for surgical treatment when diagnosed at an advanced stage. Less than 20% of pancreatic cancers are resectable when diagnosed, and those which are resectable often still result in micrometastases. Unlike other types of cancer, pancreatic cancer typically does not manifest symptoms until it is at an advanced stage and the presenting symptoms are relatively non-specific to pancreatic cancer. These symptoms include abdominal pain, jaundice, pruritis, and darkened urine. Patients also usually present with weight loss and lack of appetite.<sup>1</sup> These symptoms overlap with other less severe types of gastrointestinal conditions, which can often delay proper diagnosis.

Another reason for the difficulty in identifying pancreatic cancer is the lack of screening for pancreatic in the general population. Currently, the International Cancer of the Pancreas (CAPS) Consortium only recommends surveillance for individuals in the high-risk population given the limitations in efficacy of these methods in the general population.<sup>6</sup> The current practice

in place for pancreatic cancer surveillance is annual imaging of the pancreas by either MRI with magnetic resonance cholangiopancreatography (MRCP) or endoscopic ultrasound (EUS).<sup>6</sup>

The concept of universal screening for pancreatic cancer in the general population has been discussed, however there are several issues with this practice. While extremely lethal, pancreatic cancer is a rare form of cancer. Because it is a rare cancer, universal screening would result in unnecessary cost and invasive procedures for most of the population. Additionally, pancreatic cancer screening yields a relatively high number of false positives.<sup>7</sup> In a study of the efficacy of pancreatic cancer screening, in 367 subjects who underwent an EUS-FNA, nearly 4% presented with a false-positive detection of a solid pancreatic finding as malignant.<sup>8</sup>

## **2.2 Pancreatic Cancer Risk Factors**

There are many risk factors associated with pancreatic cancer. These risk factors fall into two categories: modifiable and non-modifiable. Modifiable risk factors are defined as risk factors that can be changed or eliminated. Modifiable risk factors associated with pancreatic cancer include tobacco use, obesity, and environmental exposures.<sup>1</sup> Acquired conditions of diabetes and chronic pancreatitis are also risk factors for pancreatic cancer.<sup>1</sup> Tobacco use is the strongest risk factor associated with pancreatic cancer, with a nearly 75% increased risk for pancreatic cancer in active smokers.<sup>9</sup> Additionally, an approximate 20% increased risk for pancreatic cancer persists in former smokers for 10 to 20 years following smoking cessation.<sup>10</sup>

Obesity and diabetes are also significant risk factors for pancreatic cancer. While the mechanism of association between obesity and pancreatic cancer is not entirely understood, studies show that obese individuals have a 50% increase in risk for pancreatic cancer as compared to the

general population.<sup>11</sup> Obesity often presents in conjunction with type 2 diabetes mellitus. Several studies have shown that the risk for pancreatic cancer is nearly twice as high in individuals with type 2 diabetes.<sup>11</sup> However, the relationship between pancreatic cancer and diabetes is complex and demonstrates “dual-causality.” Longstanding type 2 diabetes causes prolonged periods of high intrapancreatic insulin levels that adversely affect the pancreas and increases the risk for development of adenocarcinoma. Conversely, pancreatic cancer can contribute to exocrine insufficiency which can result in pancreatogenic diabetes.<sup>12</sup> Many research studies have aimed to better understand this relationship through evaluation of clinical features, biomarkers, and time of onset of diabetes in individuals with and without pancreatic cancer.<sup>13</sup> Determining the initial condition as diabetes or adenocarcinoma can add a vital component to early detection of pancreatic cancer.<sup>12</sup> The two risk factors of diabetes and obesity are of further concern as the incidence of these conditions continues to substantially increase in the United States population.

In addition to modifiable and acquired risk factors for pancreatic cancer, there are also a number of non-modifiable risk factors. These include conditions or features that cannot be changed or that individuals have beginning at birth. Non-modifiable risk factors associated with pancreatic cancer include age, sex, race, blood group, family history, and genetic predisposition including hereditary syndromes associated with increased risk for developing pancreatic cancer. Pancreatic cancer is considered a disease of aging. Approximately 90% of cases occur in individuals over 55, with the majority of those cases in people over 70 years of age.<sup>10</sup> Males are also at a slightly increased risk to develop pancreatic cancer as compared to females. Studies suggest that this discrepancy in gender is more likely a product of environmental and lifestyle influences as opposed to physiology.<sup>1</sup> Pancreatic cancer is noted to have a higher prevalence in certain ethnic populations, the highest of which is in African Americans. It has been suggested that the higher prevalence is

related to environmental and lifestyle factors.<sup>10</sup> However, other research indicates there may be underlying genetic influences that could be responsible for the increased prevalence in the African-American population.<sup>1</sup> Blood group has also been identified as a contributing risk factor for pancreatic cancer. Data analyses have shown that the prevalence of pancreatic cancer is higher in individuals with type A, B, or AB blood as opposed to type O due to the difference in glycoproteins found on the surface of cells.<sup>14</sup>

The last important group of non-modifiable risk factors includes family history and genetic susceptibility. Familial pancreatic cancer or the presence a pathogenic variant in a pancreatic cancer susceptibility gene results in an increased risk for an individual to develop pancreatic cancer. These hereditary causes of pancreatic cancer account for approximately 10% of cases of pancreatic cancer.<sup>1</sup>

### **2.3 Genetic Associations with Pancreatic Cancer**

Research has revealed that there are several genes and familial syndromes associated with an increased risk for pancreatic cancer (Table 1). The American Society of Clinical Oncology (ASCO) recommends that all individuals with pancreatic adenocarcinoma undergo risk assessment for a hereditary predisposition associated with an increased risk for pancreatic cancer.<sup>2</sup> Beginning with version 1.2019, National Comprehensive Cancer Network (NCCN) guidelines included personal history of pancreatic adenocarcinoma as an indication for germline genetic testing.<sup>3</sup> The current recommendation is for all individuals with pancreatic cancer to have panel testing which includes genes that have been suggested to be associated with an increased risk for pancreatic cancer.



To date, there are six hereditary cancer syndromes and two additional genes that are known to be associated with an increased risk for pancreatic cancer.<sup>15</sup> Hereditary Breast and Ovarian Cancer (HBOC) remains one of the most well-defined cancer predisposition syndromes with a substantial increase in risk for breast and ovarian cancer in women, as well as moderately increased risks for male breast cancer, prostate cancer, melanoma, and pancreatic cancer. HBOC is caused by pathogenic variants in the *BRCA1* and *BRCA2* genes. Pathogenic variants in *BRCA1* and *BRCA2* increase the risk for pancreatic cancer to 1-3% and 2-7%, respectively.<sup>16</sup>

Familial Atypical Multiple Mole Melanoma (FAMMM) is an autosomal dominant cancer predisposition syndrome characterized by multiple melanocytic nevi and an increased risk for melanoma and pancreatic cancer. This condition is caused by pathogenic variants in the *CDKN2A* gene.<sup>17</sup> The most recent data indicate the risk for pancreatic cancer associated with a *CDKN2A* pathogenic variant is 17% by age 75.<sup>17</sup> The association of pancreatic cancer and melanoma has a strong genetic cause. A study of the world's largest familial melanoma database revealed that 74% of families with pancreatic cancer and melanoma had a *CDKN2A* pathogenic variant.<sup>17</sup>

Peutz-Jeghers syndrome is a hereditary cancer syndrome associated with the highest lifetime risk for pancreatic cancer. Peutz-Jeghers syndrome is an autosomal dominant condition caused by pathogenic variants in the *STK11* gene. It is characterized by hamartomatous polyps of the gastrointestinal tract and mucocutaneous hyperpigmentation.<sup>18</sup> The types of cancer with the highest increased risk in Peutz-Jeghers syndrome are colorectal, breast, stomach, and pancreatic cancer. A meta-analysis of 210 individuals with an *STK11* germline pathogenic variant revealed a 132-fold increased risk for pancreatic cancer. This equates to a 32% lifetime risk for pancreatic cancer.<sup>18</sup> However, Peutz-Jeghers syndrome has a relatively low prevalence in the general population and is often times identified at younger ages due to the associated physical features.

Lynch syndrome is a hereditary cancer predisposition syndrome characterized by a significantly increased risk for colon cancer and endometrial cancer. There is also an increased risk for stomach, ovarian, small bowel, urinary tract, brain, and pancreatic cancer. The risk for pancreatic cancer is around 8.6 times that of the general population, with a lifetime risk of 3.7%.<sup>19</sup> Lynch syndrome is caused by a pathogenic variant in any of four mismatch repair genes; *MLH1*, *MSH2*, *MSH6*, and *PMS2*, as well as *EPCAM*. Pancreatic cancer characteristic of Lynch syndrome is often medullary type and invades into lymph nodes.<sup>19</sup>

Familial Adenomatous Polyposis (FAP) is an autosomal dominant inherited cancer syndrome caused by pathogenic variants in the *APC* gene. FAP causes the development of tens to thousands of colorectal adenomas, resulting in a 100% risk of colon cancer without intervention.<sup>15</sup> There is also an increased risk of approximately 2% for pancreatic cancer and thyroid cancer.<sup>20</sup> There are several studies that suggest an additional increased frequency of intraductal papillary and mucinous neoplasms (IPMN) in individuals with FAP. One case review describes a 48-year-old male who underwent a colectomy with ileorectal anastomosis in his youth due to a clinical diagnosis of FAP. He was later found to have an IPMN with loss of heterozygosity in the tumor. Germline testing revealed a pathogenic variant in the *APC* gene.<sup>20</sup>

Li-Fraumeni Syndrome is a severe hereditary cancer predisposition syndrome caused by germline pathogenic variants in the *TP53* gene. The *TP53* gene creates a protein that is a master regulator of the cell cycle. Somatic mutations of *TP53* are the most commonly seen alterations in tumors, occurring in around 50% of tumors.<sup>21</sup> Conversely, germline pathogenic variants in *TP53* are rare in the general population. Germline pathogenic variants cause an increased risk for a wide spectrum of early-onset cancers. These most commonly include breast, sarcoma, adrenocortical, and brain cancers.<sup>22</sup> The exact risk for pancreatic cancer in a *TP53* pathogenic variant is unknown.

However, in a study of 24 individuals with a *TP53* pathogenic variant, there was an increased relative risk for pancreatic cancer as compared to that of the general population.<sup>23</sup>

The contribution of *PALB2* to germline causes of cancer is becoming more recognized. *PALB2* is associated with a significantly increased lifetime risk of breast cancer and more recently, research has shown that *PALB2* is also associated with an increased risk of other cancers, including pancreatic cancer.<sup>23</sup> The relative risk for an individual with a *PALB2* pathogenic variant to develop pancreatic cancer is 2.37 as compared to the general population.<sup>24</sup> *PALB2* works together with the *BRCA2* gene in the DNA repair process. One study in 2013 evaluated the presence of *PALB2* and *BRCA* pathogenic variants in cases of familial breast and pancreatic cancer. Of 96 individuals with familial pancreatic cancer, 3.1% were found to have a pathogenic variant in *PALB2*.<sup>23</sup>

*ATM* is another gene associated with an increased risk for pancreatic cancer and is most commonly associated with Ataxia Telangiectasia. Ataxia Telangiectasia is an autosomal recessive condition that primarily affects the nervous system and immune system causing chronic lung infections, slurred speech, and as per the name; ataxia and telangiectasias. More recent research has identified the association of a single pathogenic variant in *ATM* with an increased risk for breast, prostate, and pancreatic cancer.<sup>25</sup> One article reports the odds ratio for development of pancreatic cancer in individuals with a pathogenic variant in the *ATM* gene as 4.21 as compared to the general population.<sup>26</sup> A review of the International Cancer Genome Consortium in 2015 identified an *ATM* pathogenic variant in up to 18% of individuals with pancreatic ductal adenocarcinoma.<sup>27</sup>

Familial pancreatic cancer accounts for a portion of hereditary causes of pancreatic cancer. A diagnosis of Familial pancreatic cancer is defined by 2 or more first-degree relatives with pancreatic cancer who do not have any other inherited cancer predisposition syndrome or identified

germline pathogenic variant associated with an increased risk for PDAC.<sup>28</sup> A study conducted by researchers at Johns Hopkins concluded that individuals with two affected first-degree relatives have a 6.4-fold increased risk for pancreatic cancer. Furthermore, individuals with three or more affected first-degree relatives have a 17-fold increased risk for pancreatic cancer. Genome-wide association studies (GWAS) continue to search for loci indicative of an increased risk for pancreatic cancer in families with familial pancreatic cancer.<sup>28</sup>

**Table 1: PDAC Risk in Hereditary Cancer Predisposition Genes**

<u>Hereditary Cancer Predisposition Syndrome</u>	<u>Genes</u>	<u>Pancreatic Cancer lifetime risk</u>
Peutz-Jeghers syndrome	<i>STK11</i>	32%
Familial Atypical Multiple Mole Melanoma	<i>CDKN2A</i>	17%
Lynch syndrome	<i>MLH1, MSH2, MSH6, PMS2, EPCAM</i>	3.7%
Familial Adenomatous Polyposis	<i>APC</i>	1-2%
Hereditary Breast and Ovarian Cancer	<i>BRCA1</i> <i>BRCA2</i>	1-3% 2-7%
Li-Fraumeni syndrome	<i>TP53</i>	increased
	<i>ATM</i>	increased
	<i>PALB2</i>	increased

## 2.4 Implications of Genetic Testing in Affected Individuals

While the survival rate for pancreatic cancer is low regardless of the presence or absence of a genetic predisposition, advances in medicine have shown the clinical utility of identifying a pathogenic variant in a pancreatic cancer predisposition gene in an individual with pancreatic cancer. Targeted treatments are available for individuals with pancreatic cancer that harbor pathogenic variants in specific genes.

Platinum-based chemotherapy has shown clinical benefits in individuals who have a pathogenic variant in *BRCA1* or *BRCA2*. Without functional BRCA proteins, cells cannot correctly repair DNA in the presence of platinum drugs, which results in cell death.<sup>29</sup> This makes platinum-based chemotherapy more effective in treating cancer in the presence of a *BRCA* pathogenic variant. It is often used in conjunction with other therapeutic agents or prior to surgery.<sup>29</sup>

PARP inhibitors are another type of targeted therapy for pancreatic cancer in the presence of pathogenic variants in the BRCA pathway. PARP is an acronym for Poly (ADP-ribose) polymerase and is a class of enzymes that function in the DNA repair pathway for single-stranded breaks. In the presence of a defective DNA repair mechanism caused by a pathogenic variant in *BRCA*, the use of PARP inhibitors can lead to cell death as opposed to proliferation of damaged cells.<sup>30</sup> One recent phase 3 clinical trial evaluated the use of PARP inhibitors in individuals with metastatic pancreatic cancer and a pathogenic variant in *BRCA1* or *BRCA2*.<sup>31</sup> This trial showed the progression free survival doubled for affected individuals in the group taking PARP inhibitors after first-line chemotherapy as compared to the placebo group.

An additional type of targeted therapy is available for pancreatic tumors that are mismatch repair deficient (dMMR) or have microsatellite instability (MSI). Mismatch repair is a vital process that occurs within cells to identify and repair mismatched DNA bases that arise during cell replication.<sup>32</sup> Cancerous tumors which exhibit loss of proteins associated with mismatch repair genes are often caused by Lynch syndrome. Pancreatic tumors that present as dMMR/MSI-high have a high mutation burden and may respond to an immunotherapy called Pembrolizumab.<sup>33</sup> Pembrolizumab is a programmed cell death-1 (PD-1) inhibitor which functions by binding to the PD-1 ligand to allow activation of T-cells which recognize and attack cancer cells.<sup>34</sup> This is often used in the treatment of dMMR/MSI-high colorectal cancer, and has been shown to have a similar

response in other types of cancer, including pancreatic adenocarcinoma. There is limited research regarding the effectiveness of pembrolizumab in the management of pancreatic cancer due to the rarity of dMMR/MSI-high PDAC. However, one study showed normalization of CA19-9 levels and regression of disease in several individuals with pancreatic cancer who underwent additional treatment with PD-1 immunotherapy.<sup>33</sup>

## **2.5 Implications of Genetic Testing in Unaffected Individuals**

Identification of a pathogenic variant causing a hereditary cancer predisposition can have significant implications for unaffected individuals. There is a baseline risk of developing cancer that exists for all individuals in the general population, however, identification of a cancer predisposition can provide additional information on certain cancer risks and lead to recommended surveillance and prevention strategies. This is particularly pertinent for pathogenic variants in pancreatic cancer predisposition genes as it is currently not recommended for the general public to undergo screening for pancreatic cancer. This recommendation is mostly due to the limitations, cost-effectiveness, and efficacy of surveillance. The International Cancer of the Pancreas Screening (CAPS) Consortium, American Gastroenterological Association, and National Comprehensive Cancer Network (NCCN) recommend pancreatic cancer surveillance for high-risk individuals. However, the specific guidelines and recommendations of surveillance vary between these organizations, mainly due to differing opinions regarding the limited clinical utility of surveillance. The most recent guidelines from CAPS, updated in 2020, categorizes high-risk individuals into three groups.<sup>6</sup> The first category includes individuals with a pathogenic variant in *STK11* or *CDKN2A*, who should be offered surveillance regardless of family history due to the

high lifetime-risk for pancreatic cancer. The second category includes individuals with a pathogenic variant in *BRCA2*, *BRCA1*, *PALB2*, *ATM*, *MLH1*, *MSH2*, or *MSH6*, who should be offered surveillance when they have at least one affected first-degree relative. The third category includes individuals who meet criteria for familial pancreatic cancer (FPC). Unaffected individuals from families with FPC would be recommended to consider pancreatic cancer surveillance if they have at least one affected first-degree relative.<sup>6</sup>

The recommendations for age to begin pancreatic cancer surveillance is dependent on the risk category. For individuals who have a known pathogenic variant in *STK11* or *CDKN2A*, surveillance is recommended to begin at age 40. For individuals who have a known pathogenic variant in *BRCA2*, *ATM*, *PALB2*, *BRCA1*, *MLH1/MSH2/MSH6*, surveillance is recommended to begin at age 45 or 50, or 10 years before the earliest diagnosis of pancreatic cancer in the family. For individuals considered high-risk due to a classification of familial pancreatic cancer, surveillance is recommended to begin at 50 or 55, or 10 years before the earliest diagnosis of pancreatic cancer in the family.<sup>6</sup>

The two imaging tests primarily used for surveillance for pancreatic cancer include magnetic resonance imaging of the abdomen (MRI) and endoscopic ultrasound (EUS). Abdominal MRI is a type of non-invasive magnetic resonance imaging that produces detailed images of the liver, gallbladder, bile ducts, pancreas and pancreatic duct.<sup>35</sup> Endoscopic ultrasound is an invasive imaging test that involves inserting an endoscope into the mouth and down to the first part of the small intestine. The tip of the tube contains an ultrasound probe that is able to capture images of the surrounding organs using sound waves.<sup>36</sup> Few studies have evaluated the efficacy of the two techniques in detecting pancreatic cancer lesions. One meta-analysis found that EUS is a better method for detection of small solid lesions, with a sensitivity of 93% for lesions less than 2cm,

compared to 67% detection for MRI.<sup>37</sup> Conversely, another study found that MRI/MRCP is a better method for detection of cystic lesions. In a study of 166 individuals at high-risk for developing pancreatic cancer, 23 individuals were found to have a cystic lesion. These lesions were detected only by MRI and not EUS.<sup>38</sup> Due to the discordance in detection ability, combined MRI and EUS remains the recommended modality of screening.<sup>6</sup> CAPS currently recommends baseline MRI and EUS combined with annual imaging of the pancreas. Many sites alternate MRI and EUS, however, there is no consensus as to if and how these modalities should be alternated.<sup>6</sup>

In addition to imaging tests, some guidelines recommend measurement of hemoglobin A1c (HbA1c) at baseline or the initial evaluation and during routine follow-up surveillance.<sup>6</sup> HbA1c is a measure of glycated hemoglobin. The pancreas plays a vital role in maintenance of blood glucose levels in the body. Elevated HbA1c is often a sign of diabetes or prediabetes but can additionally indicate the presence of a malignant pancreatic lesion. A prospective cohort study evaluated records of 238 individuals seen in a pancreatic cancer multidisciplinary clinic due to a recent elevation of hemoglobin-A1c and an identified pancreatic lesion; 196 of these individuals were found to have a malignant neoplasm of the pancreas.<sup>39</sup>

Additional testing is recommended for individuals suspected of having a pancreatic neoplasm based on routine surveillance outcomes. CAPS recommends CA19-9 serum testing and CT depending on the outcome of routine surveillance.<sup>6</sup>

The primary goal of pancreatic cancer surveillance is to prevent death from pancreatic cancer, ideally by identifying a cancer when the tumor is small and confined to the pancreas or an advanced precursor lesion (cystic lesion with high-grade dysplasia). A prospective study analyzed data from 354 individuals classified as high-risk for PDAC who were enrolled in a Johns Hopkins Cancer of the Pancreas Screening cohort studies from 1998 through 2014.<sup>40</sup> These individuals



underwent routine surveillance with MRI and EUS. At median follow-up of 5.6 years into the study, 30 asymptomatic individuals were diagnosed with a clinically significant primary pancreatic neoplasm. Additionally, 71% of PDAC's detected were stage I or stage II indicative of a dramatic downstage from the typical detection of PDAC at stage IV.<sup>40</sup>

Pathogenic variants in pancreatic cancer predisposition genes that increase the risk of pancreatic cancer most often increase the risk of other cancers as well. Identifying a pathogenic variant in an unaffected individual may indicate the need for increased surveillance or consideration of risk-reducing surgery. In individuals identified to have a pathogenic variant in BRCA1 or BRCA2, increased breast surveillance is recommended beginning at age 25, with the greatest risk-reduction through a surgical intervention of bilateral mastectomy.<sup>41</sup> In individuals with a pathogenic variant in one of the mismatch repair genes, increased screening beginning at an earlier age is recommended for the detection of colon cancer.<sup>42</sup> Identifying a pathogenic variant in an individual that increases the risk for pancreatic cancer has the utility of leading to risk management options for other types of cancer.

## **2.6 Virtual Genetic Counseling**

Genetic counseling is a rapidly growing field, with employment growth around 27% in the past two years and predictions for that rate to continue through 2028.<sup>43</sup> With the wave of genetic discoveries since completion of the Human Genome Project in 2003 and the rapid integration of genetic testing into clinical practice, the demand for the knowledge and skillset of genetic counselors has greatly increased. In 2017, there were only approximately four-thousand genetic counselors in the United States. Models estimate that given the current number of clinical genetic

counselors and growth rate for demand, there will be a shortage of around 1,000 genetic counselors for the United States population through the year 2026.<sup>4</sup>

The shortage of genetic counselors can lead to a variety of challenges, one including wait-time for an appointment. The average time between requesting an appointment with a genetic counselor and having the appointment varies immensely between specialties and geographic location. Studies have shown that these wait time can be anywhere from two weeks to three months.<sup>44</sup> Average wait times for a cancer genetic counseling appointment have been recorded as 32-43 days in the National Cancer Centre Singapore, 23 days at St. Luke's Mountain States Tumor Institute, and 42-100 days in the Ontario Breast Screening program.<sup>44,45</sup> For individuals with cancer, long wait times to see a genetic counselor can cause barriers to optimal care for them and their families. Genetic testing results have the potential to impact treatment for an individual with pancreatic cancer. Genetic testing results of an individual with cancer can also inform the need for genetic testing of other family members. Because pancreatic cancer has such a rapid lethality, it is especially important to minimize genetic counseling appointment wait times for affected individuals.

This discrepancy in supply and demand of genetic counseling services has created the need for utilization of alternative service delivery models. Nearly 50% of genetic counselors use alternative service delivery models including telephone, telemedicine, and group counseling.<sup>46</sup> This evaluation was from 2016, prior to the COVID-19 pandemic when clinical genetic counseling services were almost exclusively provided via telehealth early in the pandemic.

Telehealth is the use of a technology-based virtual platform to provide healthcare and deliver information. An important reason behind the creation of the telehealth model was to provide services for individuals in rural or international locations, individuals that could not leave

their homes, and for appointments with rare specialists.<sup>47</sup> Currently, the utilization of telehealth has significantly increased. There are two main sources of telehealth: video conference and telephone. Video conferencing consists of face-to-face interaction with a healthcare provider through a HIPAA compliant web-based platform, such as Doxy.me or Thera-LINK. Telephone telehealth consists of traditional telephone interaction where you can hear or speak with the healthcare provider but not see them. The more novel approaches to virtual healthcare are the use of asynchronous telemedicine and pre-recorded video.

Asynchronous telemedicine occurs when the event of a healthcare provider sharing information and the event of the patient or other healthcare provider receiving the information do not have to occur simultaneously.<sup>48</sup> In other words, a healthcare provider can review imaging, labs, medical records and create a care plan that a patient can then view without that healthcare provider being present. Asynchronous telemedicine does have restrictions that do not exist for synchronous telemedicine. For example, asynchronous telemedicine cannot be used in emergency or adaptive situations.<sup>48</sup>

The concept of asynchronous telemedicine has been applied to pre-recorded videos for health education. The use of these videos is comparable to the concept of a flipped classroom model. In a flipped classroom model, students gain foundational knowledge by viewing PowerPoint presentations, reading book chapters, or watching pre-recorded lectures. The students then use that foundational knowledge to engage in assignments and in-class discussion.<sup>49</sup> This same concept applies to the use of pre-recorded videos, in which patients can view a video presenting relevant health education information and then follow up with a healthcare provider with any questions. While the interactions between patients and health care providers are significantly different from that of students and professors, the similarities in this situation reflect

the concept of providing foundational knowledge via video and then following up with an expert. One study has been done to evaluate the cross-bridge of a flipped classroom model as a means of presenting medical information.<sup>50</sup>

This study took place in Pakistan and included a pre-recorded video which educated medical students about physician-patient communication skills. An assessment was done to evaluate the communication skills each physician used to present certain clinical counseling topics to patients, before and after watching the educational video. A statistical difference in scoring of communication skills suggests that video education was an effective teaching method.<sup>50</sup>

The use of pre-recorded video in genetic counseling is beginning to find footing in the field as a new way to combat the shortage of genetic counseling services. There are many studies that assess the use of interactive video health education, but minimal published research on the topic of pre-recorded video health education and even less on the use of the model in genetic counseling. One study trialed the use of animated videos in a pediatric emergency department waiting room. These videos provided tips for managing common illnesses at home and alternative ways of seeking medical advice that did not involve the emergency department. Twenty-two of twenty-seven parents who viewed the video reported that the video would influence their behavior the next time their child was sick.<sup>51</sup>

Two studies have evaluated the use of video education in genetic counseling. One study was the MAGENTA trial, which evaluated the utility of video education regarding genetic testing with and without pre- and post- test genetic counseling.<sup>52</sup> The goal of this study was to make genetic testing more widely available for individuals at risk for hereditary breast and ovarian cancer given a family history of the condition or personal history of breast cancer. The primary outcome of the study was evaluation of cancer risk distress in patients after receiving education

about genetics and cancer. Results showed that the video education was successful in reducing patient distress.<sup>52</sup> Another study evaluated the use of a genetic counseling educational video for women with ovarian, fallopian, and peritoneal carcinomas. The purpose of this study was to evaluate the proportion of women who elected to undergo genetic testing after the video education compared to those who were offered an in-person appointment with a genetic counselor.<sup>53</sup> The results of this study showed that 29% of individuals who were offered an appointment with a genetic counselor underwent genetic testing and 55% of individuals who had video education underwent genetic testing.<sup>53</sup> The reasoning behind this difference requires further evaluation and is not resistant to the influence of potential external factors such as declining of counseling services, insurance coverage, and language limitations. However, the findings of this study offer evidence of the utility of video education in providing genetic information.

## **2.7 Influence of Health Literacy in Genetic Counseling**

Health literacy is defined as “the degree to which individuals have the capacity to obtain, process, and understand basic health information and services.”<sup>54</sup> More than one-third or 80 million adults in the United States have limited health literacy.<sup>54</sup> Limited health literacy makes it difficult for individuals to understand health information and make informed decisions. This subsequently results in a number of burdens for the healthcare system, including increased health-care costs, limited patient knowledge of their own diseases and treatments, fewer self-management skills and ability to care for chronic conditions, poor compliance, increased hospitalizations, and reduced access to correct health care services.<sup>55</sup>

Health literacy in the context of genetic counseling becomes particularly complicated. Genetic counseling is by nature a non-directive type of health care interaction. Genetic information is presented to patients, typically with the caveat of patients then choosing their next steps, e.g., the decision to pursue genetic testing. This focus on patient autonomy makes health literacy even more paramount to ensure that patients have a sufficient level of comprehension of the information being presented in order to make an informed decision. One study assessed genetic literacy through administration of a questionnaire which addressed basic concepts of genetics to over 5,000 participants. The average correct score on the questionnaire was 65.5%, which represents significant limitations in genetic literacy in the population.<sup>56</sup>

There are many reasons for which individuals decline genetic testing in the presence of a personal cancer diagnosis. Several studies have evaluated the factors that play a role in decision making for genetic testing. One study looked at individuals who faced the opportunity to undergo genetic testing for hereditary colorectal cancer syndromes. The most common reasons for people to decline genetic testing after receiving education about the testing options were: lack of understanding about the purpose and benefits of genetic testing, belief that the test result wouldn't alter their care, and insurance concerns.<sup>57</sup> Another study analyzed individuals who were eligible for *BRCA1/BRCA2* testing, and found that 44% of individuals pursued genetic testing and 56% declined testing. Interviews with the study participants revealed the most common reason they pursued genetic testing was due to the desire to better manage their own cancer risk and the cancer risk for close relatives. Conversely, the most common reasons participants declined testing was the perceived irrelevance of the result on their health management and concerns about insurance discrimination.<sup>58</sup>

Many connections have been made which demonstrate the influence of health literacy on the decision-making process to pursue or decline genetic testing. One study found that individuals with limited health literacy were significantly less likely than those with adequate health literacy to perceive family history as very important in the decision to pursue genetic testing.<sup>59</sup> Another study analyzed the connection between health literacy and cancer risk perception through discussion of the recurrence risk for breast cancer. Results concluded that individuals with lower health literacy gave more variable interpretations of presented risks and had a reduced ability to associate risk with recommendations for chemotherapy.<sup>60</sup>

These findings indicate that an individual's level of health literacy influences their ability to understand both personal and family cancer risk information, and subsequently their ability to make an informed decision about pursuing genetic testing. In other words, if an individual with limited health literacy has a lower proclivity to understand their personal risk for cancer occurrence when they have a pathogenic variant, then they may be less likely to pursue genetic testing despite the recommendations about subsequent surveillance.

A study through the National Institute of Aging analyzed the ability of patients to correctly recall health information being orally presented to them by a healthcare provider, in relation to the patient's baseline health literacy.<sup>61</sup> Results of the study showed significant reduction in patient recall of information in individuals with limited health literacy. The outcome demonstrated patient recall mean scores of 2.5 in the low literacy group vs 4.6 in the adequate literacy group with a significant p-value of less than 0.001. Additionally, individuals with adequate literacy had a recall rate as low as 31% for specific items. This suggests a lack of understanding of health care information even in individuals with adequate health literacy.

Health literacy is additionally an important factor in influencing the incidence of cancer. While many types and diagnoses of cancer are unpreventable, we do know there are modifiable risk factors that increase an individual's chance of developing cancer. An analysis of the 2013 U.S. Health Information National Trends Survey evaluated the correlation between health literacy and cancer prevention beliefs.<sup>62</sup> Individuals with low health literacy were significantly more likely to endorse the notion that *cancer prevention is not possible* than individuals with higher health literacy. This is reflective of the association of limited health literacy with comprehension of proper health maintenance recommendations.

Given the significant impact of health literacy on decision-making and behaviors, certain tools have been developed to gauge patient health literacy in the field of genetics. The Rapid Estimate of Adult Literacy in Genetics (REAL-G) questionnaire was developed as a tool for determination of genetic literacy.<sup>63</sup> The short form is comprised of 8 words commonly used in cancer and/or prenatal genetic counseling. Participants are asked to read the words aloud. Individuals who cannot pronounce 3 or more words fall into the category of low literacy, equating to a reading level at or below 6<sup>th</sup> grade. Analysis of the utility of this tool revealed a sensitivity of 89.3% and a specificity of 80.8% to identify individuals with low literacy.<sup>63</sup>

## **2.8 Patient Satisfaction of Virtual Health Education**

The National Society of Genetic Counselors (NSGC) has long focused on patient-centered healthcare. The statement of Diversity, Equity, and Inclusion states “The skills of genetic counselors are exactly those needed to promote a diverse and inclusive organization: empathy, tailored communication, problem solving, advocacy, and the ability to support people of all



backgrounds through important moments in their lives.” With the movement of genetic counseling into mainstream healthcare comes the challenge of ensuring patient satisfaction with genetic counseling services. Few studies and data analyses have been performed to sift through the gaps in communication that occurs when presenting a particularly complex field of medical science through a non-interactive video.

Disconnect in communication between patient and provider is a particularly salient issue in the growth of telemedicine and online education tools. This is because any problems with comfort, communication, and satisfaction have the potential to become exacerbated when moved to a virtual platform. While many studies have been done to evaluate the efficiency and functionality of health care provided via a virtual platform and patient satisfaction of telehealth services, research regarding patient satisfaction of video education of genetic counseling information is significantly lacking.<sup>64-66</sup>

A pilot study was performed over the period of four years at two hospitals in California to evaluate patient review of communication and satisfaction regarding an in-person genetic counseling appointment.<sup>67</sup> One hundred seventy genetic counseling sessions were observed to assess the mismatch of patient information needs and information provided by counselors. The main components of the session that yielded ineffective communication were (1) too much information; (2) complex terminology and conceptually difficult presentation of information; (3) information perceived as not relevant by the patient; (4) unintentional inhibition of patient engagement and question asking; (5) vague discussions of screening and prevention recommendations. Mismatch information issues that exist with in-person genetic counseling may be even more difficult to address in interactions that eliminate active engagement between genetic counselor and patient.

A meta-analysis looked at multiple studies that evaluated patient satisfaction with telemedicine. Telemedicine was shown to have various impacts on quality of care in comparison to in-person counseling. Improvements in telemedicine revolved around convenience. Reductions in patient satisfaction of telemedicine included absence of body language communication, back and forth discussion, and delivery of handouts.<sup>68</sup> Another pilot study through a stroke center in Houston analyzed the use of a pre-recorded video to provide health education to individuals who had undergone a stroke.<sup>69</sup> A 5-minute video regarding stroke education was presented to participants upon hospital discharge along with a 10-item questionnaire. Prior to watching the video, 49.5% of participants were “very satisfied” with the stroke education they had received while in the hospital. There was a significant increase in satisfaction after watching the video of 74.2% of participants saying they were “very satisfied.”

Results of these studies represent the need for additional analysis of patient satisfaction of telehealth genetic counseling. This analysis would focus on aspects unique to pre-recorded video education as opposed to live telemedicine sessions. Future directions for studies would combine the evaluation of effectiveness and patient satisfaction of pre-recorded videos.

### **3.0 Manuscript**

#### **3.1 Background**

Pancreatic ductal adenocarcinoma (PDAC) is one of the most lethal forms of cancer. In recent years, PDAC has been responsible for over 400,000 deaths globally each year. While the United States has made many advancements in medicine and treatment, PDAC remains the third most common cause of cancer-related deaths in the United States, with a 5-year survival rate of 9%.<sup>1</sup>

Extensive research has identified many factors that cause an increased risk for PDAC. These factors include modifiable risks such as tobacco use, obesity, and environmental exposures and non-modifiable risk factors such as age, gender, race, blood group, family history, and genetic predisposition.<sup>9-11,14</sup> Approximately 10% of individuals with PDAC harbor a germline pathogenic variant in a gene associated with increased risk for cancer.<sup>1</sup> An increased risk for PDAC has been associated with many hereditary cancer predisposition syndromes that have well-defined risks for various types of cancer and guidelines for risk management. These syndromes include Hereditary Breast and Ovarian Cancer syndrome (HBOC), Lynch Syndrome, Peutz-Jeghers syndrome, Familial Atypical Multiple Mole Melanoma (FAMMM), Familial Adenomatous Polyposis (FAP), and Li-Fraumeni syndrome.<sup>15</sup> New research continues to identify additional genes that are associated with an increased risk for PDAC.<sup>16,23,25</sup>

Current guidelines recommend a genetics evaluation and germline genetic testing for a hereditary cancer predisposition for all individuals diagnosed with PDAC.<sup>3,6</sup> Determining the germline status for individuals with PDAC can inform the cancer risks for family members and

potentially impact treatment of the affected individual. Pathogenic variants in certain genes are more likely to respond to specific medications that can further aid in treatment of cancer.<sup>29,30,34</sup> The International Cancer of the Pancreas (CAPS) Consortium has specific recommendations for PDAC surveillance in high-risk individuals.<sup>6</sup> High-risk individuals include those identified to have a genetic predisposition to PDAC. Studies have shown that routine surveillance can identify PDAC at earlier, more treatable stages.<sup>40</sup>

Genetic testing for hereditary cancer predisposition syndromes is often facilitated by genetic counselors. However, the current genetic counseling workforce is not meeting the demand for their services nationwide, which limits the completion of this testing.<sup>4</sup> While germline genetic information can be theoretically tested at any time due to its fixed nature, individuals with PDAC often do not have time. The poor average survival rates from this cancer means that individuals may die before obtaining access to genetic services. Additionally, genetic counselors are mainly located in high-population urban settings, resulting in limited access to genetic services.<sup>47</sup> Limitations such as cancer lethality and limited access to genetic counseling services represent the need for exploration of alternative service delivery models.

Video education has become a growing alternative to traditional delivery of health services. In this model, a pre-recorded video of pertinent health information is presented to patients, with the opportunity to follow-up with a health care provider if needed.<sup>48</sup> This information delivery method had been evaluated in two genetic studies as a means to make genetic testing more widely available to individuals.<sup>52,53</sup> One of these studies resulted in a 55% uptake of genetic testing for individuals who received video education.<sup>53</sup> However, the use of video education has the potential to exacerbate the communication issues and emotional burden that comes from learning complex and potentially life-changing genetic information.<sup>67</sup>

The purpose of this study was to evaluate the effectiveness and patient satisfaction of video education discussing the genetics of PDAC. Most studies of web-based healthcare delivery assess the functionality of live telehealth consultations. There is minimal published information regarding the use of pre-recorded videos in the field of genetics, and even less information regarding patient satisfaction of such videos as an educational tool. This study aims to guide future directions for the delivery of genetic information about PDAC in a manner that addresses some of the challenges associated with access within the field of genetic counseling.

## **3.2 Methods**

### **3.2.1 Participants**

IRB approval for this study was granted on November 6, 2019 and the approval letter can be found in Appendix A.5. The University of Pittsburgh Medical Center (UPMC) created a Multidisciplinary Clinic (MDC) for patients newly diagnosed with PDAC. The clinic is designed with the goal of having all necessary specialists meet with the patient in one appointment. Specialists include medical oncologist, surgical oncologist, pain management, dietician, clinical trials coordinators, clinical labs coordinators, and genetic counselors. A conference is held prior to each clinic in which all the specialists review imaging, labs, pathology reports, and medical history in order to determine the treatment plan for each patient.

The clinic is held one day a week and takes place in two locations. The morning clinic is held at Hillman Cancer Center and the afternoon clinic is held at Presbyterian Hospital. The clinic structure and specialists available are the same at both clinics. The two study groups were assigned

based on clinic location. Patients seen at Hillman Cancer Center were assigned to the traditional genetic counseling group and patients seen at Presbyterian Hospital were assigned to the video education group.

### **3.2.2 Eligibility Criteria**

The inclusion criteria for this study are individuals with histologically confirmed pancreatic ductal adenocarcinoma who were being seen in the MDC. Patients were eligible regardless of age, sex, stage of disease, and personal or family history of cancer. The exclusion criteria for this study are individuals who had an identified pathogenic variant in a cancer predisposition gene, individuals who previously underwent multi-gene germline panel testing that included pancreatic cancer susceptibility genes, and individuals who could not provide informed consent to participate in the research study.

### **3.2.3 Recruitment**

In both clinics, potential participants were invited to participate during their appointment in their exam room. It was explained to patients that they would be either meeting with a genetic counselor or watching an educational video about genetics, dependent on their clinic site. Details of the study, including all research related activities, were reviewed with the patients. All questions regarding participation were answered and patients who agreed to participate in the study provided informed consent. Subsequent genetic counseling or video education and questionnaire administration also took place in the patient's exam room.

### **3.2.4 Data Collection Tools**

In this research study, three questionnaires were used to collect data for evaluation of endpoints. Copies of all questionnaires are located in Appendix A. The REAL-G instrument is a validated questionnaire that was used to assess participants' baseline genetic literacy. The Genetic Knowledge Questionnaire was designed for this study to assess participants' pancreatic cancer genetic knowledge. The Patient Satisfaction survey was designed for this study to assess participants' satisfaction of their designated delivery method of genetics education.

The REAL-G was completed verbally by the patient. The Genetics Knowledge Questionnaire was administered orally by the research investigator reading the prompts out loud. The Patient Satisfaction Survey was completed by the patient in writing.

#### **3.2.4.1 REAL-G Short Form**

The Rapid Estimate of Adult Literacy in Genetics (REAL-G) is a validated questionnaire that was developed based on the Rapid Estimate of Adult Literacy in Medicine (REALM) as a means to achieve an understanding of individuals' baseline level of health literacy.<sup>63</sup> The REAL-G consists of 63 words frequently discussed in prenatal and/or cancer genetic counseling sessions. The REAL-G short form was adapted from the original questionnaire and consists of 8 words commonly discussed in genetic counseling. The REAL-G short form was used in this study to measure each participant's familiarity with genetic terms prior to receiving any genetics education.

After completing the consent process, participants were given the REAL-G short form and asked to read the words out loud. They were instructed to pronounce all words to the best of their abilities and told that they could skip over any word they could not pronounce. The investigator administering the instrument also had a copy of the questionnaire in order to track the participant's

responses. The words in the REAL-G short form are “genetic,” “sporadic,” “mutation,” “variation,” “chromosome,” “hereditary,” “abnormality,” and “susceptibility”.

Words that the participant pronounced correctly were marked with a “+” on the investigator’s form. Words that the participant pronounced incorrectly or skipped were marked with a “-“ on the investigator’s form. A total of 3 or more missed or skipped words equates to a 6<sup>th</sup> grade or below reading level.<sup>63</sup>

#### **3.2.4.2 Genetic Knowledge Questionnaire**

The Genetics Knowledge Questionnaire was constructed specifically for this study. No published questionnaires could be identified in the literature that include all the necessary aspects to accomplish the aims of this study. A genetics questionnaire for adolescents and young adults with congestive heart failure was used as framework for the creation of this questionnaire.<sup>70</sup> The Genetics Knowledge Questionnaire was designed to evaluate patient knowledge of genetic information about PDAC that was addressed during their appointment at the MDC.

The questionnaire was created by the investigators, including two genetic counselors who specialize in gastrointestinal cancer genetics. The questionnaire consists of seven true/false statements. Each statement was assigned one point. Individuals who answered the statement correctly received one point and individuals who did not answer the statement correctly received zero points. Therefore, the maximum number of points someone could receive was seven. The statements each contain information about the genetics of pancreatic cancer that was presented to the participant either by the genetic counselor or through the educational video.

The questionnaire was intended to be administered verbally by a study investigator at two timepoints. The first timepoint was in-person in the MDC immediately following genetic education. The second timepoint occurred over the phone at a time interval detailed in the study



protocol. During both timepoints, the investigator read each statement out loud and prompted the participant to classify each statement as true or false based on the genetics education they received. The investigator marked a “√” in the appropriate column on their form. The number of questions that the participant correctly designated as true or false was recorded.

### **3.2.4.3 Patient Satisfaction Questionnaire**

The Patient Satisfaction Questionnaire was constructed specifically for this research study. There are no published questionnaires in the literature that specifically address patient satisfaction regarding delivery of genetics education using a pre-recorded video. Two satisfaction questionnaires for traditional genetic counseling sessions were used as the platform for creation of this questionnaire.<sup>71,72</sup> The Patient Satisfaction Questionnaire was designed to evaluate patient satisfaction of their designated method of delivery of genetic information about PDAC during their appointment including assessment of clarity, relevance, directiveness, reliability, personalization, trustworthiness, and ability to prepare individuals to make a decision about genetic testing.

The questionnaire was created by the investigators and the advisory team for this research study. The questionnaire consists of seven statements to which the study participants respond using a Likert scale. The statements contain information discussing evaluation and impression of the mode of delivery of genetic information. The Likert scale includes the options “strongly disagree,” “disagree,” “neutral,” “agree,” and “strongly agree.” Each statement in the Likert scale was assigned a certain number of points: 1- strongly disagree, 2 – disagree, 3 -neutral, 4 – agree, 5 – strongly agree. Three statements were intentionally made negative statements to ensure that individuals were reading and comprehending the questionnaire, and to eliminate response bias. The three negative statements were reverse scored in data analysis of satisfaction responses. A higher score equates to a more positive reaction to the statement.

The questionnaire was administered at one timepoint by the investigator during the MDC clinic immediately following genetic education. The participant was given a copy of the questionnaire and asked to read it and complete it themselves by marking their responses with a “√” in each appropriate column.

### **3.2.5 Study Protocol**

The research team for this study consisted of a genetic counseling student who facilitated the enrollment process and administration of questionnaires, two cancer genetic counselors, several surgical oncologists and medical oncologists, a gastroenterologist, and additional research coordinators. The study consisted of two parts. Part one was a continuation of the pilot study which assessed participant genetic knowledge. Part two was a novel addition to the study which assessed participant satisfaction.

Recruitment of patients into the research study occurred in the MDC. Patients who met the inclusion criteria were approached during clinic, provided information about participation in the study and given the opportunity to ask questions. Patients who declined participation in the study were still offered the opportunity to receive genetics education and pursue genetic testing during MDC or through referral to the Hereditary GI Tumor program. Patients who agreed to participate in the study provided informed consent by reviewing and signing the consent form.

The consent process was followed by the activities of timepoint 1. The REAL-G questionnaire was administered, and responses recorded. In the traditional genetic counseling group, the genetic counselor then met with the patient and provided genetic counseling. The results of the REAL-G were not disclosed to the genetic counselor prior to their discussion with the patient in order to prevent bias in their counseling style. The traditional genetic counseling session was

an abbreviated version of a standard cancer genetic counseling appointment to accommodate the nature of a multidisciplinary clinic. This consisted of collection of a pedigree, education about hereditary pancreatic cancer, discussion of the risks, benefits, and result outcomes of genetic testing, and completion of paperwork if appropriate. This also included the opportunity for patients to ask questions of the genetic counselor. Time spent with the genetic counselor was variable, but typically lasted approximately 20 minutes.

In the video education group, a 5-minute video was played for the patient to provide genetics education after the completion of the REAL-G questionnaire. The video was developed by licensed and certified genetic counselors who specialize in gastrointestinal cancer genetics. This video was a narrated PowerPoint slide deck presented on a tablet. The video included a brief education about hereditary pancreatic cancer, and discussion of the risks, benefits, and result outcomes of genetic testing. The video directed the participants to bring any questions they may have to the providers at the MDC. A pedigree was not collected for individuals in the video group.

Immediately following the genetics session in both groups, the participants were administered the Genetics Knowledge Questionnaire orally by the investigator and responses were recorded. The participants were then given the Patient Satisfaction Questionnaire to complete and the instrument was retrieved and kept by the investigator. Participants were instructed to complete the questionnaires on their own without assistance from any individuals that may have accompanied them to the appointment.

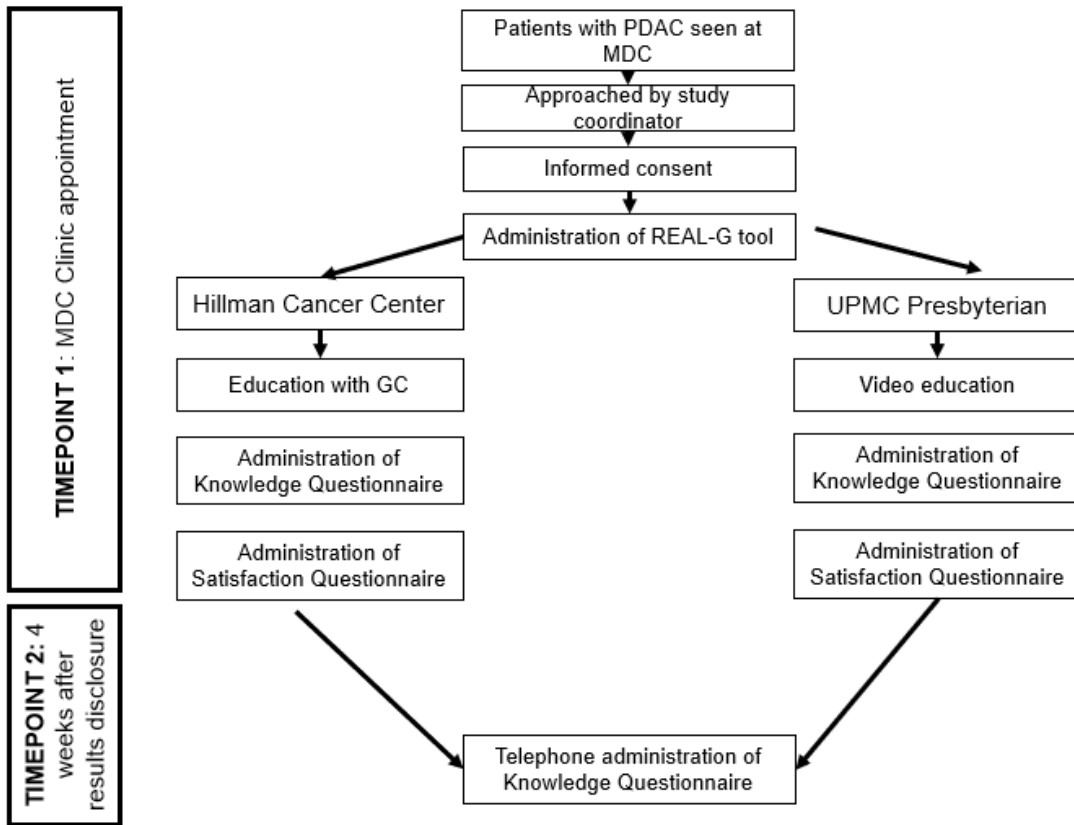
Participants who elected to undergo genetic testing were offered testing through Invitae's Detect study, which waives the price of the genetic test for individuals with PDAC. Study participants were aware that testing was being offered at no cost. For the Detect study, participants who underwent genetic testing prior to April 2020 received a panel containing 84 genes and

participants enrolled after April 2020 received a panel containing 49 genes associated with increased risk for pancreatic cancer and other cancers. A complete list of analyzed genes can be found in Appendix C. Genetic testing was completed via a blood sample upon conclusion of the MDC appointment. If the genetic testing was not able to be completed on the day of the appointment, participants were sent a saliva kit to mail in their specimen for genetic testing.

Timepoint 2 occurred four weeks after the participants' appointment at the MDC. Participants were contacted via telephone. At this time, participants were reminded of their participation in the study and were asked if they would answer follow-up questions for data collection. If the participant agreed, then the Genetics Knowledge Questionnaire was administered. The investigator re-explained the instructions of the questionnaire and then read the statements out loud and recorded the responses. Participants were then thanked for their participation in the research study and were told their participation was complete. If participants did not agree to answer follow-up questions, then they were told their participation was complete.

Genetic testing results were returned to the participant when they became available. Participants in the traditional genetic counseling group received their results over the phone from the genetic counselor they spoke with at the time of their MDC appointment. Participants in the video education group received results from a member of the MDC care team who was trained by the genetic counselors to return results. Any participant who was in the video education group and was found to have a pathogenic variant was referred to meet with a genetic counselor in the Hereditary GI Tumor program for a comprehensive discussion.

**Figure 1: Protocol Workflow**



### 3.2.6 Data Analysis

The software systems Microsoft Excel and STATA (StataCorp version 15) were used for all data analyses. Non-parametric tests were used given the lack of normal distribution and small sample sizes. A Fisher’s Exact Test was used for comparisons of sex and literacy with education group. A Wilcoxon rank-sum (Mann-Whitney) test was used for comparisons of age, knowledge score, and satisfaction score between the two groups, and a comparison of genetic literacy group with knowledge score. A Wilcoxon signed-rank test was used to compare knowledge scores between timepoints. A Spearman correlation test was used to compare interval between timepoints

and change in knowledge score. P values were considered significant when less than 0.05. Output from STATA can be found in Appendix B.

### **3.3 Results**

Recruitment of participants for part one of the study began January 8<sup>th</sup>, 2020, and ended December 9<sup>th</sup>, 2020. Recruitment was temporarily ceased for three months due to the COVID-19 pandemic. A total of 64 participants consented to be in part one of the study, which evaluated patient knowledge. Thirty-two participants were enrolled in each group; video education group and traditional genetic counseling group. Each of these participants completed the REAL-G questionnaire and knowledge questionnaire at timepoint one. Of the 64 participants, 50 participants completed timepoint two. Fourteen participants were not able to complete timepoint two for the following reasons: two died before reaching timepoint two, six were lost-to-follow-up, and six elected not pursue genetic testing and were therefore not eligible for timepoint two.

Recruitment of participants for part two of the study began September 16<sup>th</sup>, 2020, and ended December 9<sup>th</sup>, 2020. A total of 25 patients were enrolled in the second portion of the study, which evaluated patient satisfaction. Each of these participants completed the patient satisfaction questionnaire at timepoint one. Eleven participants were enrolled into the traditional genetic counseling group and fourteen participants were enrolled into the video education group.

### 3.3.1 Demographics

Of the 64 participants, the overall mean age was 67.9 ( $\pm$  9.95) with a range of 41 to 87 years. The mean age of the traditional genetic counseling group was 69.5 ( $\pm$  8.66) with a range of 52 to 87 years. The mean age of the video education group was 66.2 ( $\pm$  10.85) with a range of 41 to 84 years. There was no significant difference between age for groups (p-value = 0.3400). Of the total participants, 62.5% (40) were male and 37.5% (24) were female. In the traditional education group, 53.1% (17) were male and 46.9% (15) were female. In the video education group, 71.9% (23) were male and 28.1% (9) were female. There was no significant difference between sex for groups (p-value = 0.196) (Table 2).

**Table 2: Participant Demographics**

Group	Traditional Education	Video Education	Total
	n = 32	n = 32	n = 64
<b>Age (years)</b>			
<b>Mean</b>	69.5	66.2	67.9
<b>Range</b>	87-52 = 35 years	84-41 = 43 years	87-41 = 46 years
<b>Sex proportion (n)</b>			
<b>Male</b>	53.1% (17)	71.9% (23)	62.5% (40)
<b>Female</b>	46.9% (15)	28.1% (9)	37.5% (24)

### 3.3.2 Baseline Genetic Literacy

Baseline genetic literacy was determined from administration of the REAL-G questionnaire. Of the 64 total participants, 15.6% (10) were identified to have low literacy 95% CI [0.067-0.245]. There were 12.5% (4) individuals with low literacy in the traditional education

group 95% CI [0.044-0.206] and 18.8% (6) individuals with low literacy in the video education group 95% CI [0.092-0.284]. There was no significant difference between literacy for education groups (p-value = 0.732) (Table 3).

**Table 3: Genetic Literacy**

Literacy Group	Traditional Education	Video Education	Total
	n=32	n=32	n=64
6 <sup>th</sup> Grade or Below	12.5% (4)	18.8% (6)	15.6% (10)
Above 6 <sup>th</sup> Grade	87.5% (28)	81.3% (26)	84.4% (54)

### 3.3.3 Genetic Knowledge in Comparison to Literacy and Education Group

Genetic knowledge was determined from the Genetic Knowledge Questionnaire. The mean number of questions answered correctly across all groups and literacy levels following genetics education was 5.7 ( $\pm 0.95$ ) out of possible 7. The mean knowledge score for individuals determined to have low literacy was 5.3 ( $\pm 1.2$ ) and those determined to have adequate literacy is 5.8 ( $\pm 0.87$ ). There was no statistical difference between literacy level and knowledge score (p-value = 0.2284) (Table 4).

The mean knowledge score for individuals with low literacy in the traditional education group was 5.0 ( $\pm 1.41$ ) and the mean score for those with low literacy in the video education group was 5.5 ( $\pm 0.96$ ). The mean knowledge score for individuals with adequate literacy was 5.8 in both traditional and video education groups.



**Table 4: Mean Knowledge Score by Literacy Level and Education Group**

<b>Literacy Group</b>	<b>Traditional Education</b>	<b>Video Education</b>	<b>Overall</b>
6 <sup>th</sup> Grade or Below	5.0	5.5	5.3
Above 6 <sup>th</sup> Grade	5.8	5.8	5.8
Total Average	5.4	5.7	

\*Mean score on the knowledge questionnaire out of 7 possible points

### **3.3.4 Genetic Knowledge Across Timepoints**

The study protocol indicated four weeks between timepoint 1 and timepoint 2 to administer the knowledge questionnaire. However, for logistical reasons this interval was not always four weeks. The mean interval between timepoints was 32 days ( $\pm 8.79$ ). A correlation test was performed to determine if length of interval time influenced change in knowledge score between timepoint 1 and timepoint 2. There was no statistical correlation between interval time and change in knowledge score (p-value = 0.4211).

Sixty-four participants were enrolled in part one of this study and completed the genetic knowledge questionnaire at timepoint 1. Fifty participants completed the genetic knowledge questionnaire at timepoint 2 and were analyzed across both timepoints (Table 5). The mean knowledge score for all participants in both groups at timepoint 1 and timepoint 2 was 5.7 ( $\pm 0.95$ ) and 5.3 ( $\pm 1.11$ ), respectively. There was no statistical difference in overall knowledge score between timepoint 1 and timepoint 2 (p-value = 0.1359).

The mean knowledge score for timepoint 1 and timepoint 2 in the traditional education group was 5.7 ( $\pm 0.99$ ) and 5.3 ( $\pm 1.10$ ), respectively. This represented an average reduction in knowledge score for the second timepoint of 0.25 ( $\pm 1.43$ ), which was not statistically significant (p-value = 0.4096). Thirteen participants had a decrease in knowledge score at timepoint 2 as

compared to timepoint 1, nine participants had an increase in knowledge score at timepoint 2, and six participants had the same knowledge score at both timepoints.

The mean knowledge score for timepoint 1 and timepoint 2 in the video education group was 5.8 ( $\pm 0.90$ ) and 5.2 ( $\pm 1.13$ ), respectively. This represented an average reduction in knowledge score for the second timepoint of 0.45 ( $\pm 1.27$ ), which was not statistically significant (p-value = 0.1573). Nine participants had a decrease in knowledge score at timepoint 2 as compared to timepoint 1, six participants had an increase in knowledge score at timepoint 2, and seven participants had the same knowledge score at both timepoints.

**Table 5: Mean Knowledge Score by Timepoint**

	<b>Timepoint 1</b>	<b>Timepoint 2</b>	<b>Average Change in Knowledge</b>
	n=64	n=50	
Traditional Education	5.7	5.3	- 0.25 ( $\pm 1.43$ )
Video Education	5.8	5.2	- 0.45 ( $\pm 1.27$ )

### 3.3.5 Satisfaction in Comparison to Education Group

Participant satisfaction of their education method was measured through administration of the satisfaction questionnaire at timepoint 1. Comparison of satisfaction scores and corresponding p values can be found in Table 6. The mean satisfaction score for statement one in the traditional education group and video education group was 4.1 ( $\pm 1.00$ ) and 3.9 ( $\pm 0.80$ ), respectively, which was not statistically significant (p-value = 0.5206). This was a negative statement which was reverse scored for the data analysis. The mean satisfaction score for statement two in the traditional

education group and video education group was 3.7 ( $\pm$  1.05) and 3.9 ( $\pm$  0.70), respectively, which was not statistically significant (p-value= 0.8577). The mean satisfaction score for statement three in the traditional education group and video education group was 3.8 ( $\pm$  1.11) and 4.3 ( $\pm$  0.45), respectively, which was not statistically significant (p-value= 0.3159).

The mean satisfaction score for statement four in the traditional education group and video education group was 4.4 ( $\pm$  0.77) and 4.1 ( $\pm$  0.96), respectively, which was not statistically significant (p-value = 0.4162). This was a negative statement which was reverse scored for the data analysis. The mean satisfaction score for statement five in the traditional education group and video education group was 3.8 ( $\pm$  1.19) and 4.4 ( $\pm$  0.48), respectively, which was not statistically significant (p-value= 0.3279).

The mean satisfaction score for statement six in the traditional education group and video education group was 3.8 ( $\pm$  0.94) and 2.9 ( $\pm$  0.88), respectively, which was not statistically significant (p-value = 0.0537). This was a negative statement which was reverse scored for the data analysis. The mean satisfaction score for statement seven in the traditional education group and video education group was 4.0 ( $\pm$  0.95) and 4.1 ( $\pm$  0.52), respectively, which was not statistically significant (p-value= 0.9027).

The total satisfaction score (out of possible 35 points) was calculated for each participant and compared between traditional and video education groups. The mean total satisfaction score for the traditional education group was 28.9 ( $\pm$  3.29) and for the video group 26.6 ( $\pm$  3.81), which was not statistically significant (p-value= 0.1048).

**Table 6: Satisfaction Score by Education Group**

<b>Statement</b>	<b>Traditional Education</b>	<b>Video Education</b>	<b>P-value</b>
The information presented about genetic testing was difficult to follow	*4.1	*3.9	0.5206
The information presented about genetic testing felt relevant to my diagnosis	3.7	3.9	0.8577
The information provided explained the purpose of genetic testing for a person with pancreatic cancer	3.8	4.3	0.3159
Based on the information presented (in the video/by the genetic counselor), I do not feel comfortable making a decision about getting genetic testing	*4.4	*4.1	0.4162
I trust that the information about genetic testing presented (in the video/by the genetic counselor) is accurate	3.8	4.4	0.3279
I wish I had more of an opportunity to ask questions about genetic testing	*3.8	*2.9	0.0537
I would recommend (the video/speaking with a genetic counselor) to other people with pancreatic cancer as a way to learn about genetic testing	4.0	4.1	0.9027
Total Satisfaction Score	28.9	26.6	0.1048

*\*Reverse scored*

### **3.3.6 Genetic Testing Results**

Of the sixty-four participants who were enrolled in part one of this study, fifty-seven elected to undergo genetic testing. Three of the individuals who elected to undergo genetic testing never had their sample collected. For these three individuals, genetic testing was not able to be completed on the day of the appointment so alternative options were discussed to complete the

genetic testing at a later time. None of these three individuals had results returned by the completion of the data analysis. Four individuals underwent genetic testing, but the results were not made available to the study team. Of the 50 participants whose results were returned by the completion of the study, 9 were identified to have a pathogenic variant, 17 were identified to have at least one variant of uncertain significance (VUS), and 24 had negative results. This means that 18% of participants in this study with pancreatic ductal adenocarcinoma were identified to have a pathogenic variant in a hereditary cancer predisposition gene 95% CI [0.07-0.29]. Four of the participants with a pathogenic variant were in the traditional education group and five were in the video education group.

The pathogenic variants were identified in *ATM*, *APC*, *BLM* (heterozygous), *BRCA2*, *CHEK2* (x2) *MUTYH* (x2, heterozygous) and *TP53* (mosaic). The variants of uncertain significance were identified in *APC*, *AXIN2*, *BRCA1*, *CDKN2A*, *CEBPA*, *MET*, *MSH2*, *MSH3*, *NF2*, *PDGFRA*, *PMS2*, *POLE*, *RAD50*, *RECQL4*, *SDHA*, and *TSC2*.

### **3.4 Discussion**

In 2018, the American Society of Clinical Oncology updated their guidelines to recommend universal genetic testing for a hereditary predisposition to cancer in all individuals with pancreatic ductal adenocarcinoma (PDAC).<sup>2</sup> The National Comprehensive Cancer Network shortly followed suit and updated their clinical criteria for genetic testing to include anyone with a diagnosis of PDAC.<sup>3</sup> This prompted the demand for oncology genetic counselors to accommodate these new testing recommendations. Genetic counseling continues to be a developing field, with a shortage of genetic counselors per individual in need of genetic services

in the United States estimated to persist through the year 2026.<sup>4</sup> This projection was based off U.S. and U.K. data evaluating supply and demand of genetic counseling services, which concluded a recommendation of one full-time equivalent genetic counselor per 75,000 people in the United States.<sup>43</sup> This discrepancy in supply and demand of genetic counselors prompts the need for alternative methods of delivering genetic counseling services. University of Pittsburgh Medical Center (UPMC) created an educational video about genetic testing for pancreatic cancer in effort to increase access to germline genetic testing. By using an educational video to explain genetic testing for pancreatic cancer, genetic counselors can focus their services on individuals identified to have a pathogenic variant for a more detailed discussion of what it means for them and their families.

The goal of this study was to assess the effectiveness and satisfaction of this video education model to determine if it would be a viable method of delivery of genetic information. A pilot study was created in 2019 which analyzed effectiveness of this video through assessment of knowledge retention.<sup>73</sup> The current study continued data collection of the pilot study, and assessed the additional component of patient satisfaction. Individuals who underwent video education were compared with individuals who had traditional in-person genetic counseling with a genetic counselor. Studies have been published which analyze the use of educational videos in healthcare, however, there are limited studies which assess participant knowledge and satisfaction of this delivery method.<sup>52,53,69</sup>

A major driver of this study was the need to increase access to genetic testing in individuals with PDAC. One of the outcomes analyzed was effectiveness of video education. Of the sixty-four participants in the study, fifty-nine elected to proceed with genetic testing. This represents an overall planned uptake of genetic testing in 89% of participants, 91% in the traditional education

group and 88% in the video education group. Therefore, there was no significant difference in uptake of genetic testing between groups. This suggests that video education does not reduce patients' understanding of why genetic testing may be relevant for themselves and their families. This result is comparable to other research studies that evaluated change in behavior following video education. One study trialed the use of animated videos in a pediatric emergency department waiting room to provide tips for managing common illnesses at home. Twenty-two of twenty-seven participants reporting that the video would influence their behavior, correlating to 81.5%.<sup>51</sup> Another study evaluated the use of a genetic counseling educational video for women with ovarian, fallopian, and peritoneal carcinomas. Of the total participants, 55% of participants elected to pursue genetic testing.<sup>53</sup>

Research has shown that limited health literacy makes it difficult for individuals to understand health information and make informed decisions, which results in numerous burdens on the healthcare system and lack of proper care.<sup>55</sup> In this study, 15.6% of individuals were identified to have low genetic literacy. This is lower than the average number of individuals in the United States with limited health literacy of approximately 33% and the average score on a genetics basics questionnaire of 65%.<sup>54,56</sup> Probable explanations for this difference include; individuals with limited health literacy may not have sought care at a tertiary medical center, are located in different geographic regions than was evaluated by this study, declined participation in the study, or the sample size was not large enough. A study through the National Institute of Aging analyzed the ability of patients to correctly recall health information being orally presented to them by a healthcare provider, in relation to the patient's baseline health literacy. Results of this study showed reduction in patient recall of information in individuals with limited health literacy. Mean score in the low literacy group was 2.5 and mean score in the adequate literacy group was 4.6.<sup>61</sup>

Given the outcomes of this prior research study, we anticipated that performance on the knowledge questionnaire would be influenced by participants' genetic literacy. The mean knowledge score for individuals determined to have low literacy was 5.3 ( $\pm$  1.2) and those determined to have adequate literacy was 5.8 ( $\pm$  0.87). Data analysis showed that this difference was not statistically significant. This unexpected conclusion may be due to the small sample size.

We hypothesized that participants in video education group would not score differently than those in the traditional education group on the knowledge questionnaire. The video was designed to cover an abbreviated version of the same information about genetic testing that a cancer genetic counselor would address in a traditional counseling session. The mean knowledge score for timepoint 1 in the traditional education and video education groups was 5.7 ( $\pm$  0.99) and 5.8 ( $\pm$  0.90), respectively. This showed no statistical significance between knowledge score of both groups. Part of the genetic counseling training includes skills to assess patient health literacy and adjust the conversation accordingly. Consequently, it is possible that literacy would have a greater influence on knowledge score in the video education group. This was not found as the mean knowledge score for individuals with low genetic literacy was slightly higher in the video group as compared to the traditional education group.

We anticipated that individuals would have a lower knowledge score on timepoint 2 as compared to timepoint 1. The structure of the MDC clinic involves discussion with multiple healthcare providers on the day of the appointment, resulting in a substantial amount of information being presented to the patient. Given the nature of pancreatic ductal adenocarcinoma, it is likely that the majority of these conversations included poor and perhaps devastating news. We know that when people are experiencing psychological distress, they have limited ability to retain information.<sup>74</sup> Therefore, we anticipated their retention of genetics education would be



reduced weeks following the initial appointment. The majority of patients in both traditional and video education group experienced a reduction in knowledge score at timepoint 2. A smaller group of individuals experienced an increase in knowledge score or a knowledge score that stayed the same between timepoints. The difference in knowledge retention was not significant between education groups, suggesting that patients have the same ability to retain knowledge from a video as they do from a genetic counselor.

The revised study protocol indicated that timepoint 2 should occur four weeks after timepoint 1. Timepoint 2 was completed over the phone. Given logistical limitations of being able to contact patients over the phone, the interval between timepoints varied between participants. Research has shown that knowledge retention decreases as time passed increases.<sup>75</sup> Therefore, we speculated that increased time between intervals could be correlated with a decrease in knowledge score at timepoint 2. A correlation test was performed to assess the association between the difference in knowledge score and the length of interval between timepoints. There was no significant statistical difference in knowledge score based on interval between timepoints.

The pilot study for this research sought to analyze the effectiveness of video education for genetic testing in individuals with pancreatic cancer. Effectiveness was determined by retention of knowledge and uptake of genetic testing between education groups. Preliminary results from the pilot study indicated that there was no statistical difference in effectiveness between the traditional genetic counseling and video education group.<sup>73</sup> This research study continued assessment of effectiveness to determine if the statistical outcome would change with a larger sample size. Results of this study confirmed that there is no statistical difference in efficacy between groups. This study also analyzed the additional component of patient satisfaction regarding receiving video education. The ultimate goal of this research is to determine if video education can be used for

delivery of genetic information. Consequently, we must determine if video education is both effective and satisfactory.

Satisfaction was determined through administration of the satisfaction questionnaire. The satisfaction questionnaire was designed specifically for this study to assess multiple dimensions of patient satisfaction. Prior research studies which have evaluated the use of telemedicine show the greatest reduction in satisfaction derived from the absence of body language communication, back and forth discussion, and delivery of handouts.<sup>68</sup> We therefore anticipated the greatest negative response in the video education group for the question, “I wish I had more of an opportunity to ask questions about genetic testing.” In order to improve access to genetic information, this educational video could be utilized in a setting where genetic counselors are not immediately available. Consequently, the greatest limitation of video education would be the inability to engage in a discussion of question and answer. The mean satisfaction score for this question was lower in the video education as compared to the traditional education group, with a p-value of 0.0537 which approaches statistical significance. This suggests a potential limitation of the video education in the inability to ask questions after viewing the video. This can be a significant hindrance in the ability to make an informed decision about genetic testing and the ability for patients to accurately understand what genetic testing means for them and their family. Genetics is a particularly complex field and genetic counseling training emphasizes the importance of eliciting and addressing questions throughout the genetic counseling appointment. Potential research to address this issue is discussed in the future directions section of this paper.

While lack of ability to ask questions raises doubt as to whether or not patients are properly informed to make a genetic testing decision, this concern was in part addressed in another portion of the satisfaction questionnaire. One statement in this questionnaire was “Based on the

information presented [in the video/by the genetic counselor], I do not feel comfortable making a decision about getting genetic testing.” The mean score for this question was 1.6 ( $\pm 0.77$ ) and 1.9 ( $\pm 0.96$ ) for the video education and traditional education groups, respectively. This is interpreted with the trend towards disagreement with the statement, indicating that people **did** feel comfortable making a decision about the testing after receiving genetics education. There was no statistical difference in this analysis between tradition and video education groups. These findings suggest that while many people in the video education group wished they had more of an opportunity to ask questions, they still felt comfortable to make a decision about genetic testing.

All other questions in the satisfaction questionnaire were analyzed. There was no significant difference in response to these questions individually and the total satisfaction score between education groups. Overall, the analyses from part 2 of this research study reveals that video education is a satisfactory method of delivering genetics education about genetic testing for pancreatic cancer.

Telemedicine has long been a component in health information delivery. However, with alternative methods of using technology for health education, the results of this study are both contributory and novel information regarding the use of pre-recorded videos for delivery of genetic information for genetic testing in individuals with PDAC.

### **3.4.1 Study Limitations and Future Directions**

Perhaps the biggest limitation of this study is lack of analysis regarding the effectiveness of delivery of genetic testing results in the video education and traditional education groups. The goal of this study was to determine if video education is both an effective and satisfactory method to deliver information about genetic testing so that individuals with pancreatic ductal

adenocarcinoma can make an informed decision about whether or not to pursue testing. However, this study did not evaluate if video education is an effective method for the continuation of care through proper receipt of genetic testing results.

In the traditional education group, two genetic counselors who specialize in gastrointestinal cancers were in charge of tracking and returning genetic testing results to patients. All results were returned to patients in a timely manner over the phone regardless of whether the results were negative, VUS, or pathogenic variant. The result disclosure was documented in the patients' electronic medical record (EMR) as a telephone encounter, the results were scanned into the patients' EMR, and the patients were mailed a copy of their results and a summary letter. In the video education group, the medical oncologist, surgical oncologist, or a member of their care team was in charge of tracking and returning genetic testing results to patients. Although these individuals received verbal training, written protocols, and disclosure templates from the genetic counselors so that result disclosure would mirror that of the genetic counselors, these processes were not utilized. Result disclosure was not documented in the EMR and the study team has no means of determining if or when patients were notified of their results, aside from the individuals with a pathogenic variant who were referred for counseling. We do not have sufficient information to determine reason for lack of proper results return.

While return of results with a pathogenic variant is most important for immediate impact on the affected individual and their family, knowledge of a negative result or VUS is still essential. A negative result is pertinent information for family members in terms of recommendations for pancreatic cancer surveillance and genetic testing guidance should additional family members develop cancer. A VUS is important for the same reasons as a negative result in addition to the potential for this variant to be reclassified as pathogenic. Consequently, the genetic testing process

is insufficient when all results are not returned. This lack of proper results return in the video education group represents significant limitations to the utility of this delivery method for genetic testing education. If this method were to be utilized in future at other healthcare locations, either a different protocol would need to be established in order to ensure proper results return or checkpoints would need to be in place to ensure that the original protocol is followed. Genetic counseling assistants may be a useful asset to facilitate the administrative and logistic aspects of proper results return.

Another limitation resulting in insufficient completion of the genetic testing process, is the lack of proper follow-up for individuals identified to have a pathogenic variant in the video education group. The video provides only brief education about genetic testing in a 5-minute power point presentation with recorded audio. The video is not designed to be a comprehensive discussion of cancer risks, surveillance and/or surgical guidelines, and familial risk for individuals with a pathogenic variant identified through testing. Consequently, participants should have a follow-up discussion with a genetic counselor about implications of the specific variant identified. Participants who do not have a follow-up appointment receive incomplete genetic counseling and therefore are not properly informed of all the implications of the variant.

In the video education group pathogenic variants were identified in *MUTYH*(x2), *CHEK2*(x2), and *BRCA2*. Only two of these five participants in the video group had their follow-up consultation with a genetic counselor. This means that three individuals and their families are not properly informed about the implications of their pathogenic variant. Limitations of this study prevent us from knowing whether or not they received genetics education from an outside source, e.g., oncologist, primary care physician, or genetic counselor at an external institution. All participants in the traditional genetic counseling group received a follow-up call or appointment

after return of results, which included a detailed discussion of implications of the pathogenic variant, if applicable. This imbalance in care between the video education and traditional genetic counseling group represents a drawback in the video education method in providing patients with comprehensive and complete genetic testing results education. A future direction for this study could be to analyze patient actions following a result which revealed a pathogenic variant, possibly through administration of a follow-up questionnaire for patients with a positive result ascertaining their subsequent plans for action.

Another major limitation of this study was the ability to *guess* the correct answer on the knowledge questionnaire. Data analysis showed that while there was a reduction in knowledge score between timepoint 1 and timepoint 2, the change was not large enough to be statistically significant. However, when speaking with patients over the phone to administer the knowledge questionnaire at timepoint 2, the vast majority of participants admitted they did not remember the answer to any of the statements or that they didn't remember watching the video/speaking with the genetic counselor. These participants subsequently answered the knowledge questionnaire based on common sense or random guess, as opposed to memory from their initial MDC appointment. The knowledge questionnaire consists of True and False statements. Therefore, there is a 50% chance that someone guessing on the questions without remembering their genetics education could guess correct. While the ability to guess on the knowledge questionnaire was also a factor in timepoint 1, patients reported their inability to remember the genetics education with much greater frequency in timepoint 2. This provides significant limitation to the validity of knowledge retention assessment. Additionally, this reduces efficacy of both methods of delivering genetics education since most participants did not remember the information presented in the genetics education.

One possibility for this inability to recall the conversation, could be the circumstances of receiving the information. The MDC visits are typically the first time patients are receiving details of their diagnosis, outcome for survival, and information about the impact on quality of life. Given the mortality of PDAC, this is typically distressing news. Following the delivery of this news, the patients meet with multiple providers each presenting their agenda of recommendations and care plans. Multiple fields of research show a reduction in ability to retain information in times of stress, shock, and information overload.<sup>74</sup>

One area of future research to address this concern could be to assess the efficacy of providing genetics education outside of the MDC appointment. This could entail meeting with the genetic counselor/viewing the video at an appointment after the initial MDC clinic. This would allow time for the patient to grasp the diagnosis and breadth of information presented by other providers in the multidisciplinary team before hearing information about genetics. While time is one of the major reasons for employing this alternative method of genetics education, patients with PDAC will typically start treatment and care immediately. Therefore, patients will likely return to the hospital very soon after their MDC appointment when genetics education could be delivered. One limitation of this method would be that some individuals decide to seek care at a more geographically local hospital.

Another potential barrier to administration of this video education tool in future clinics and hospitals lies in the logistics of viewing and playing the video. In this research study, the study coordinator brought the tablet containing the genetics education video into each of the patient rooms, set up and played the video for each participant, waited for conclusion of the 5-minute video, and then retrieved the tablet to repeat the process with the next patient. While this is a simple task, in an MDC clinic of multiple specialty providers with their own agenda and high volume of

patients to attend, this raises the dilemma of who will administer the video. This may also be a suitable role for a genetic counseling assistant. A solution to this issue may be more easily solved in some locations versus others depending on the available resources. For example, some clinics may have a medical assistant who can administer the video for each patient or some clinics may have a tablet already set in each patient room to which the video can be uploaded with easy instructions for the patient to play the video themselves. However, neither of these are currently available options in the Pittsburgh Hillman Cancer Center and UPMC Presbyterian Hospital raising suspicion that these limitations may also be present in other locations.

Another limitation of this study inherently exists in the study design; the two groups do not experience each other's version of genetics education. It is plausible that if the video education group were to have understood that the traditional education group received more comprehensive genetics education and had the opportunity for question/answer discussion, then the participants in the video education group would have ranked lower on the satisfaction survey. However, this limitation may have been ruled out by the chance that this concept could apply in an opposite manner. The MDC appointment is several hours long with multiple providers presenting a vast amount of information. Therefore, patients may actually be more satisfied with the brief and non-interactive video education than they would with a more lengthy presentation by a genetic counselor.

### **3.4.2 Conclusion**

As national guidelines for genetic testing change and the subsequent demand for genetic counselors to carry out this process increases, new methods of genetic education delivery must be explored to adapt to the currently limited supply of genetic counselors. Already existing practices



in telehealth pave the way for the use of pre-recorded video education. This study was a continuation of a novel pilot study which addressed the efficacy of the use of video education to deliver information about genetic testing for individuals with PDAC. The results of this study validate the pilot study by demonstrating no significant difference in retention of knowledge between the traditional genetic counseling group and video education group. This study additionally evaluated patient satisfaction of video education. Minimal research currently exists to evaluate patient satisfaction in a non-interactive form of virtual genetics education. The results of this study conclude that there is no significant difference in patient satisfaction between the traditional education and video education group. The sample size for this portion of the study was relatively small and further evaluation may be necessary to determine the validity of this result. The findings of this study suggest that video education is both an effective and satisfactory method of delivering genetics testing information to individuals with PDAC. This is an important finding given the rapidly developing nature of genetic discovery and subsequent need for alternative methods of genetic education to facilitate utilization of this information by patients and their families.

#### **4.0 Research Significance to Genetic Counseling and Public Health**

Genetics is a unique area of medicine that can have significant and complex impacts on an individual's health. While most healthcare providers have general knowledge about genetics, research has found that many health care providers feel unprepared to discuss genetic information with their patients.<sup>76,77</sup> As genetic discoveries continue to be made at a rapid rate and genetics becomes more integrated into standard clinical care, the need for health care professionals who specialize in genetics has become paramount. Genetic counselors are specially trained to relay genetic information to patients with inclusion of detailed discussions of risk assessment, family history evaluation, diagnostic testing, screening and surveillance, genetic testing, and psychosocial implications. Current barriers exist which limit access to genetic counselors for all individuals in need of their services. This predicament has led to the exploration of alternative service delivery models.

Given the lethality of pancreatic cancer and the potential implications for both the affected individual and their family members, it is imperative to increase access to genetic testing to all individuals with PDAC in a timely manner. This study explored the use of video education as a satisfactory alternative delivery model of information about genetic testing through assessment of knowledge retention and patient satisfaction.

While traditional in-person genetic counseling remains necessary for certain discussions, generalized video education may be an appropriate approach for more routine genetics topics such as genes, chromosomes, and genetics of cancer. The use of a video for these genetic concepts would permit the limited number of genetic counselors to focus their time and availability on the more complex and personalized indications and discussions.

Genetic testing for pancreatic cancer is both a recommended and uniquely important area of cancer genetic counseling. NCCN and ASCO recommend genetic testing for all individuals with pancreatic cancer regardless of any other factors.<sup>2,3</sup> This specification lends itself easily to a standardized discussion of pre-test counseling. At UPMC, not all individuals with pancreatic cancer are referred for genetic testing or follow-through with the recommendation to speak with a genetic counselor. Therefore, the use of video education to present information about genetic testing during an oncology appointment would increase access to genetic testing while adapting to the limited number of genetic counselors. The results of this study suggest that video education is both a satisfactory and effective way of delivering information about genetic testing and therefore could be successfully utilized in genetic counseling practice.

The three core functions of public health include assessment, policy development, and assurance. This study focuses on the functions of policy development and assurance. The public health goal of expanding genetic testing to all individuals with PDAC is to reduce illness and death due to pancreatic cancer. Current plans in place do not sufficiently support this goal due to limited resources. Policy development focuses on creating plans to support community health efforts. UPMC recognized the limitations in access to genetic testing and proposed an alternative method of delivering genetic information to address this issue through the use of video education. Findings from this study suggest that video education is an appropriate system to be used in development of a new policy and procedure for genetic testing education in individuals with PDAC.

Assurance focuses on linking people to the services they need and ensuring the effectiveness, accessibility, and quality of these services. Results of this study suggest that video education is a successful method of delivery information about genetic testing. Future work could

include implementing video education for PDAC in other healthcare institutions. Ultimately, the goal is to improve access to genetic testing for all individuals with PDAC.

This study provides valuable information about the utility of video education to deliver genetic testing information for pancreatic cancer. If this method of alternative service delivery were to be employed in general genetics practice, then policies would need to be established to ensure proper access to genetic counseling; namely, a plan for return of all results and assurance of completion of the appropriate post-test counseling. Additional safeguards would need to be in place to monitor the use of video education to establish that it does not result in a deviation from appropriate access to test results and relevant genetic counseling services. While this study focused on the use of video education in genetic counseling, employment of this method of health education could expand into the wider field of healthcare.

## **Appendix A**

This appendix includes all data collection tools, the research study consent form, and the IRB study approval letter.

## Appendix A.1 Rapid Estimate of Adult Literacy- Genetics (REAL-G)

### REAL-G Short Form

You can quickly determine your patient's genetic literacy with this oral reading and recognition test, known as the Rapid Estimate of Adult Literacy in Genetics (REAL-G). It measures a patient's ability to pronounce 8 words used frequently in genetics. To use REAL-G, follow these 5 steps:

1. Give the patient a copy of the following list of words. (Keep a copy for yourself)

Genetic  
Sporadic  
Mutation  
Variation  
Chromosome  
Hereditary  
Abnormality  
Susceptibility

2. Ask the patient to read aloud as many words as they can, beginning with the first word. When they come to a word they cannot read, tell them to do the best they can or say "blank," and then go on to the next word on the list.

If the patient takes longer than five seconds to read a word, prompt them to move on by saying "blank," and pointing to the next word on the list. If the patient begins to miss every word, ask her to pronounce only those words they know.

3. On your copy of the lists, keep score of the patient's answers. Next to each correctly pronounced word, write a plus sign (+). After each word that was not attempted or was mispronounced, write a minus sign (-).

4. This total is the patient's raw score.

5. 3 or more missed words equates to a 6<sup>th</sup> grade or below reading level.

Adapted from instructions from Davis, T., Crouch, M. & Long, S. (1993). *Rapid Estimate of Adult Literacy in Medicine (REALM)*. Shreveport, LA: Louisiana State University Medical Center.

Erby LH, Roter D, Larson S, Cho J. 2007. The rapid estimate of adult literacy in genetics (REAL-G): A means to assess literacy deficits in the context of genetics. *Am J Med Genet Part A* 146A:174-181.

## REAL-G Test

Please read each word below out loud to the best of your ability. If you are not sure how to say a word, you can say “blank” and skip to the next word.

Genetic

Sporadic

Mutation

Variation

Chromosome

Hereditary

Abnormality

Susceptibility

## Appendix A.2 Pancreatic Cancer Genetics Knowledge Questionnaire

### Pancreatic Cancer Genetics Knowledge Questionnaire

	Please answer all items even if you are unsure of the answer.	True	False
1	About 20% of people with pancreatic cancer have a mutation, or harmful change, in a gene that increases their risk for pancreatic cancer.		
2	When a gene associated with pancreatic cancer is doing its job, it helps prevent cancer from forming.		
3	Genetic testing looks for mutations, or harmful changes, in genes.		
4	My doctors may be able to use genetic testing results in my pancreatic cancer treatment.		
5	If I have a mutation in a pancreatic cancer gene, my family members should consider genetic testing.		
6	Genetic testing for pancreatic cancer involves looking for a mutation in only one gene.		
7	All people who have a pancreatic cancer gene mutation will get pancreatic cancer.		



## Appendix A.3 Patient Satisfaction Survey

### VIDEO GROUP

Please tell us your opinion on the information about genetic testing that was just presented to you in the video. For each statement, please rate how much you agree or disagree using one of these options: *strongly* disagree, disagree, neutral, agree, and *strongly* agree.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1) The information presented about genetic testing was difficult to follow					
2) The information presented about genetic testing felt relevant to my diagnosis					
3) The information provided explained the purpose of genetic testing for a person with pancreatic cancer					
4) Based on the information presented in the video, I do not feel comfortable making a decision about getting genetic testing					
5) I trust that the information about genetic testing presented in the video is accurate					
6) I wish I had more of an opportunity to ask questions about genetic testing					
7) I would recommend the video to other people with pancreatic cancer as a way to learn about genetic testing					

**IN-PERSON GROUP**

Please tell us your opinion on the information about genetic testing that was just presented to you by the genetic counselor. For each statement, please rate how much you agree or disagree using one of these options: *strongly* disagree, disagree, neutral, agree, and *strongly* agree.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1) The information presented about genetic testing was difficult to follow					
2) The information presented about genetic testing felt relevant to my diagnosis					
3) The information provided explained the purpose of genetic testing for a person with pancreatic cancer					
4) Based on the information presented by the genetic counselor, I do not feel comfortable making a decision about getting genetic testing					
5) I trust that the information about genetic testing presented by the genetic counselor is accurate					
6) I wish I had more of an opportunity to ask questions about genetic testing					
7) I would recommend speaking with a genetic counselor to other people with pancreatic cancer as way to learn about genetic testing					

## Appendix A.4 Consent Form

UPMC

LIFE  
CHANGING  
MEDICINE

CONSENT TO USE MEDICAL RECORDS AND/OR  
QUESTIONNAIRES FOR RESEARCH IN THE UPMC Cancer  
Centers

### PRINCIPAL INVESTIGATOR:

Randall Brand, MD. University of Pittsburgh.  
Shadyside Medical Office Building  
5200 Centre Avenue, Suite 409  
Pittsburgh PA 15232  
(412) 623-3105

### ABOUT THE STUDY:

We are interested in understanding more about the genetic testing process for individuals with pancreatic cancer. In order to learn more, we would like to invite you to participate in a research study. The goal of this study is to collect information that will help doctors and genetic counselors better understand patients' genetic knowledge and well-being after receiving either traditional genetic counseling with a licensed genetic counselor or video education. The type of education you receive is randomly selected. We plan to recruit 200 participants to the study.

Participation would involve the following three components:

1. Your completion of surveys
2. Permission to re-contact you over the phone at later dates
3. Permission to review your medical records

### YOUR PARTICIPATION:

If you choose to participate you will be verbally asked questions during your office visit and asked to read some words out loud. These questions should take about 10 minutes to complete and will involve assessment of your genetic knowledge after receiving education. You will be randomized to receive either video education or a traditional genetic counseling with a genetic counselor. The video is approved for clinical use and has the same content as the in-person education. If you undergo genetic testing at your appointment, you will be contacted over the phone 2 weeks after disclosure of those test results and asked questions about your genetic knowledge and your perceptions of the genetic testing process; this phone call should take about 15 minutes. If you do not undergo genetic testing, you will not be contacted again by the study team. You will not be compensated for your study participation.

We are also requesting your permission to review your medical records for information about your medical history, cancer diagnosis and treatment, and family history of cancers. Information may be obtained from your medical records and used by this research team for an indefinite period of time. This authorization is valid for an indefinite period of time. However, you can always withdraw your authorization allowing the research team to review your medical records by contacting the investigator listed on the first page and making the request in writing. Any information obtained from you up to that point will continue to be used by the research team. Per the University of Pittsburgh, all research records must be maintained for at least 7 years following final reporting or publication of a project.

Participation is completely voluntary and will not affect your care or management with UPMC or any affiliated organizations. Your doctor may be involved as an investigator in this research study, but you are not under any obligation to participate in any research study offered by your doctor. Before agreeing to participate in this research study, or at any time thereafter, you may wish to discuss participation in this study with another health professional to obtain a 'second opinion' about study participation. You are free to withdraw from the study at any time, for any

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reason, without any penalty or change of care. However, any identifiable information obtained from you before you withdraw from this study will continue to be used by the investigators, as described above. You are also free to withdraw authorization for the research team to access your medical records, while still participating in the study. To formally withdraw your consent for participation in the study you should provide a written and dated notice to the primary investigator at the address above. The decision to withdraw consent from the study will have no effect on current or future medical care at a UPMC hospital or affiliated health care provider or the current or future relationship with a healthcare insurance provider.

**CONFIDENTIALITY:**

If you choose to participate in the study, your confidentiality will be protected and your personal identifying information will be coded with limited access. Your information will only be available to the research team, and possibly to auditors from the University of Pittsburgh Research Conduct and Compliance Office. There is always the small chance of a breach in confidentiality, but strong precautions and the federal confidentiality guidelines are followed to protect your information to the best of our abilities. If the researchers learn that you or someone with whom you are involved is in serious danger of harm, they will need to inform the appropriate agencies as required by Pennsylvania law. The research data collected may also be used for future unspecified research and shared in a de-identified manner with investigators both inside and outside of the University.

**RISKS AND BENEFITS**

There are no direct benefits to you involved in this study. The only risks associated with this study are the possibility of breach of confidentiality and distress associated with completion of questionnaires. There is no cost associated with this study, and neither you nor your insurance will be billed for study-related matters if you choose to participate. However, you will be responsible for standard clinical charges regardless of your participation in the study.

**VOLUNTARY CONSENT:**

This study has been explained to me, and all of my questions have been answered. Additional questions will be answered by the study team. The Human Research Subject Advocate of the University Institutional Review Board (1.866.212.2668) can answer any questions about my rights as a research subject. By signing this form, I give my authorization to share my medical records with the research team and answer their questions.

\_\_\_\_\_  
Patient/Subject Signature                      Date                      Printed Name of Patient/Subject

.....  
I certify that I have explained the nature and purpose of this research study to the above-named individual, and I have discussed the potential benefits and possible risks of study participation. Any questions the individual has about this study have been answered, and we will always be available to address future questions, concerns or complaints as they arise. I further certify that no research component of this protocol was begun until after this consent form was signed.

\_\_\_\_\_  
Signature of individual obtaining consent                      Date

## Appendix A.5 IRB Approval Letter

**University of Pittsburgh**  
***Institutional Review Board***

Human Research Protection Office  
3500 Fifth Avenue, Suite 108  
Pittsburgh, PA 15213  
Tel (412) 383-1480  
[www.hrpo.pitt.edu](http://www.hrpo.pitt.edu)

### APPROVAL OF SUBMISSION (Expedited)

Date:	November 6, 2019
IRB:	STUDY19040249
PI:	Randall Brand
Title:	Comparison of Traditional Genetic Counseling to Video Education in a Pancreatic Cancer Cohort Being Offered Genetic Testing
Funding:	None

The Institutional Review Board reviewed and approved the above referenced study. The study may begin as outlined in the University of Pittsburgh approved application and documents.

#### Approval Documentation

Review type:	Initial Study
Approval Date:	11/6/2019
Approved Documents:	<ul style="list-style-type: none"><li>• MICRA.pdf</li><li>• PDAC Genetics Knowledge Questionnaire</li><li>• REAL-G</li><li>• Video Consent</li></ul>

As the Principal Investigator, you are responsible for the conduct of the research and to ensure accurate documentation, protocol compliance, reporting of possibly study-related adverse events and unanticipated problems involving risk to participants or others. The HRPO Reportable Events policy, Chapter 17, is available at <http://www.hrpo.pitt.edu/>.

Clinical research being conducted in an UPMC facility cannot begin until fiscal approval is received from the UPMC Office of Sponsored Programs and Research Support (OSPARS).

If you have any questions, please contact the University of Pittsburgh IRB Coordinator, [Emily Bird](#).

Please take a moment to complete our [Satisfaction Survey](#) as we appreciate your feedback.

## **Appendix B**

This appendix contains data outputs from Stata.

## AGE DIFFERENCE BETWEEN EDUCATION GROUPS

Two-sample Wilcoxon rank-sum (Mann-Whitney) test

v1	obs	rank sum	expected
1	32	1111	1040
2	32	969	1040
combined	64	2080	2080

unadjusted variance      5546.67

adjustment for ties      -9.90

adjusted variance      5536.76

Ho:  $v2(v1==1) = v2(v1==2)$

z = 0.954

Prob > |z| = 0.3400

## SEX DIFFERENCE BETWEEN EDUCATION GROUPS

Key
<i>frequency</i>
<i>expected frequency</i>

group	sex		Total
	1	2	
1	17 20.0	15 12.0	32 32.0
2	23 20.0	9 12.0	32 32.0
Total	40 40.0	24 24.0	64 64.0

Fisher's exact = 0.196  
 1-sided Fisher's exact = 0.098

## LITERACY DIFFERENCE BETWEEN EDUCATION GROUPS

Key
<i>frequency</i>
<i>expected frequency</i>

group	literacy		Total
	1	2	
traditional	4	28	32
	5.0	27.0	32.0
video	6	26	32
	5.0	27.0	32.0
Total	10	54	64
	10.0	54.0	64.0

Fisher's exact = 0.732  
 1-sided Fisher's exact = 0.366

## TIMEPOINT 1 KNOWLEDGE BY LITERACY LEVEL

Two-sample Wilcoxon rank-sum (Mann-Whitney) test

literacy	obs	rank sum	expected
low literacy	10	263	325
no low lit	54	1817	1755
combined	64	2080	2080

unadjusted variance 2925.00

adjustment for ties -274.89

adjusted variance 2650.11

Ho: knowle~e(literacy==low literacy) = knowle~e(literacy==no low lit)

z = -1.204

Prob > |z| = 0.2284



## TIMEPOINT 2 KNOWLEDGE BY LITERACY LEVEL

Two-sample Wilcoxon rank-sum (Mann-Whitney) test

literacy	obs	rank sum	expected
low literacy	7	155	178.5
no low lit	43	1120	1096.5
combined	50	1275	1275

unadjusted variance      1279.25

adjustment for ties      -114.26

adjusted variance      1164.99

Ho: knowle~e(literacy==low literacy) = knowle~e(literacy==no low lit)

z = -0.689

Prob > |z| = 0.4911

## TIMEPOINT 1 KNOWLEDGE BY EDUCATION GROUP

Two-sample Wilcoxon rank-sum (Mann-Whitney) test

group	obs	rank sum	expected
traditional	32	1016.5	1040
video	32	1063.5	1040
combined	64	2080	2080

unadjusted variance      5546.67

adjustment for ties      -521.27

adjusted variance      5025.40

Ho: knowle~e(group==traditional) = knowle~e(group==video)

z = -0.331

Prob > |z| = 0.7403

## TIMEPOINT 2 KNOWLEDGE BY EDUCATION GROUP

Two-sample Wilcoxon rank-sum (Mann-Whitney) test

group	obs	rank sum	expected
traditional	28	727	714
video	22	548	561
combined	50	1275	1275

unadjusted variance      2618.00

adjustment for ties      -233.83

---

adjusted variance      2384.17

Ho: knowle~e(group==traditional) = knowle~e(group==video)

z = 0.266

Prob > |z| = 0.7901

## DIFFERENCE IN KNOWLEDGE SCORE BETWEEN TIMEPOINT 1 AND TIMEPOINT 2

(ALL)

Wilcoxon signed-rank test

sign	obs	sum ranks	expected
positive	22	743	592
negative	15	441	592
zero	13	91	91
all	50	1275	1275

unadjusted variance      10731.25

adjustment for ties      -274.88

adjustment for zeros      -204.75

---

adjusted variance      10251.63

Ho: Timepoint1 = Timepoint2

z = 1.491

Prob > |z| = 0.1359

DIFFERENCE IN KNOWLEDGE SCORE BETWEEN TIMEPOINT 1 AND TIMEPOINT 2  
(TRADITIONAL)

Wilcoxon signed-rank test

sign	obs	sum ranks	expected
positive	13	228	192.5
negative	9	157	192.5
zero	6	21	21
all	28	406	406

unadjusted variance      1928.50  
 adjustment for ties      -52.63  
 adjustment for zeros      -22.75

---

adjusted variance      1853.13

Ho: Timepoint1 = Timepoint2  
 z = 0.825  
 Prob > |z| = 0.4096

DIFFERENCE IN KNOWLEDGE SCORE BETWEEN TIMEPOINT 1 AND TIMEPOINT 2  
(VIDEO)

Wilcoxon signed-rank test

sign	obs	sum ranks	expected
positive	9	150	112.5
negative	6	75	112.5
zero	7	28	28
all	22	253	253

unadjusted variance      948.75  
 adjustment for ties      -21.25  
 adjustment for zeros      -35.00

---

adjusted variance      892.50

Ho: Timepoint1 = Timepoint2  
 z = 1.255  
 Prob > |z| = 0.2094

**CORRELATION BETWEEN TIMEPOINT INTERVAL AND CHANGE IN KNOWLEDGE SCORE**

Number of obs = 50  
 Spearman's rho = 0.1163

Test of Ho: scorechange and interval are independent  
 Prob > |t| = 0.4211

**SATISFACTION SCORE BY EDUCATION GROUP (QUESTION 1)**

Two-sample Wilcoxon rank-sum (Mann-Whitney) test

group	obs	rank sum	expected
traditional	11	154	143
video	14	171	182
combined	25	325	325

unadjusted variance 333.67  
 adjustment for ties -40.42  


---

 adjusted variance 293.24

Ho: satisf~n(group==traditional) = satisf~n(group==video)  
 z = 0.642  
 Prob > |z| = 0.5206

## SATISFACTION SCORE BY EDUCATION GROUP (QUESTION 2)

Two-sample Wilcoxon rank-sum (Mann-Whitney) test

group	obs	rank sum	expected
traditional	11	140	143
video	14	185	182
combined	25	325	325

unadjusted variance      333.67

adjustment for ties      -53.77

---

adjusted variance      279.89

Ho:  $\text{satisf} \sim n(\text{group} == \text{traditional}) = \text{satisf} \sim n(\text{group} == \text{video})$

z = -0.179

Prob > |z| = 0.8577

## SATISFACTION SCORE BY EDUCATION GROUP (QUESTION 3)

Two-sample Wilcoxon rank-sum (Mann-Whitney) test

group	obs	rank sum	expected
traditional	11	127	143
video	14	198	182
combined	25	325	325

unadjusted variance      333.67

adjustment for ties      -79.18

---

adjusted variance      254.49

Ho:  $\text{satisf} \sim n(\text{group} == \text{traditional}) = \text{satisf} \sim n(\text{group} == \text{video})$

z = -1.003

Prob > |z| = 0.3159

## SATISFACTION SCORE BY EDUCATION GROUP (QUESTION 4)

Two-sample Wilcoxon rank-sum (Mann-Whitney) test

group	obs	rank sum	expected
traditional	11	156.5	143
video	14	168.5	182
combined	25	325	325

unadjusted variance      333.67

adjustment for ties      -58.01

---

adjusted variance      275.66

Ho:  $\text{satisf} \sim n(\text{group} == \text{traditional}) = \text{satisf} \sim n(\text{group} == \text{video})$

z = 0.813

Prob > |z| = 0.4162

## SATISFACTION SCORE BY EDUCATION GROUP (QUESTION 5)

Two-sample Wilcoxon rank-sum (Mann-Whitney) test

group	obs	rank sum	expected
traditional	11	127.5	143
video	14	197.5	182
combined	25	325	325

unadjusted variance      333.67

adjustment for ties      -82.65

---

adjusted variance      251.02

Ho:  $\text{satisf} \sim n(\text{group} == \text{traditional}) = \text{satisf} \sim n(\text{group} == \text{video})$

z = -0.978

Prob > |z| = 0.3279

## SATISFACTION SCORE BY EDUCATION GROUP (QUESTION 6)

Two-sample Wilcoxon rank-sum (Mann-Whitney) test

group	obs	rank sum	expected
traditional	11	176	143
video	14	149	182
combined	25	325	325

unadjusted variance      333.67

adjustment for ties      -41.07

---

adjusted variance      292.60

Ho:  $\text{satisf} \sim n(\text{group} == \text{traditional}) = \text{satisf} \sim n(\text{group} == \text{video})$

z = 1.929

Prob > |z| = 0.0537

## SATISFACTION SCORE BY EDUCATION GROUP (QUESTION 7)

Two-sample Wilcoxon rank-sum (Mann-Whitney) test

group	obs	rank sum	expected
traditional	11	141	143
video	14	184	182
combined	25	325	325

unadjusted variance      333.67

adjustment for ties      -66.09

---

adjusted variance      267.57

Ho:  $\text{satisf} \sim n(\text{group} == \text{traditional}) = \text{satisf} \sim n(\text{group} == \text{video})$

z = -0.122

Prob > |z| = 0.9027

## SATISFACTION SCORE BY EDUCATION GROUP (TOTAL)

Two-sample Wilcoxon rank-sum (Mann-Whitney) test

group	obs	rank sum	expected
1	11	172.5	143
2	14	152.5	182
combined	25	325	325

unadjusted variance      333.67

adjustment for ties      -2.82

---

adjusted variance      330.84

Ho:  $\text{satisf} \sim n(\text{group}==1) = \text{satisf} \sim n(\text{group}==2)$

z = 1.622

Prob > |z| = 0.1048



## Appendix C

A complete list of genes analyzed as a part of Invitae's Detect Study for Hereditary Pancreatic Cancer. This panel includes 84 genes associated with pancreatic cancer and other types of cancers.

*AIP, ALK, APC, ATM, AXIN2, BAP1, BARD1, BLM, BMPRIA, BRCA1, BRCA2, BRIP1, CASR, CDC73, CDH1, CDK4, CDKN1B, CDKNIC, CDKN2A, CEBPA, CHEK2, CTNNA1, DICER1, DIS3L2, EGFR, EPCAM\*, FH, FLCN, GATA2, GPC3, GREM1\*, HOXB13, HRAS, KIT, MAX, MEN1, MET, MITF\*\*, MLH1, MSH2, MSH3, MSH6, MUTYH, NBN, NF1, NF2, NTHL1, PALB2, PDGFRA, PHOX2B, PMS2, POLD1, POLE, POT1, PRKARIA, PTCH1, PTEN, RAD50, RAD51C, RAD51D, RB1, RECQL4, RET, RUNX1, SDHA\*\*, SDHAF2, SDHB, SDHC, SDHD, SMAD4, SMARCA4, SMARCB1, SMARCE1, STK11, SUFU, TERC, TERT, TMEM127, TP53, TSC1, TSC2, VHL, WRN, WT1*

\*Deletion/duplication analysis only

\*\* Sequence analysis only

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