Proceedings from the Katz School's 2023 Symposium on Science, Technology and Health

Edited by Marissa Barrera, Sofia Binioris, Rana Khan, and Amiya Waldman-Levi

Katz School of Science and Health
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Foreword

The 20 abstracts published in these proceedings—originally presented at the Katz School's 2023 Symposium on Science, Technology and Health—offer a glimpse into the exciting work Katz School graduate students are doing to advance scholarly knowledge, impact industry challenges and transform lives.

The 2023 Symposium was held in New York City on May 11, 2023. The event was organized by the Symposium Scientific Committee, including:

Marissa Barrera, Ph.D., Assistant Dean of Health Sciences and Director, M.S. in Speech-Language Pathology

Sofia Binioris, M.A., Senior Project Manager and Advisor to the Dean

Rana Khan, Ph.D., Clinical Professor and Founding Director, M.S. in Biotechnology Management and Entrepreneurship

Amiya Waldman-Levi, Ph.D., Clinical Associate Professor and Director of Scholarship and Research of Occupational Therapy

These abstracts represent works-in-progress and are an outcome of extensive mentorship provided to students by faculty, including:

Marissa Barrera, Ph.D., CCC-SLP
Andrew Catlin
Wenxiong Chen, Ph.D.
Amber Cope, M.A.
Troy Dargin, Ph.D., CCC-SLP
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Alexandra Wagner, Ph.D., OTR/L
Fredy Zympan, Ph.D.

The Scientific Committee would also like to acknowledge Ann Leary, Denton Field, Rafael Reyes, John Vivolo, David DeFusco, and Grace Morrison for their immense contributions.

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Message from the Dean

At the Katz School, we are research scientists, tech builders and patient-centered clinicians working on problems that matter. We take an interdisciplinary approach to research and education, fostering the creativity, collaborative thinking and builder mindset required to take on today's toughest problems. In the lab, classroom and clinic, we lead with integrity, generosity and a commitment to making the world smarter, safer and healthier.

Sincerely,

Paul Russo
Paul Russo, Ph.D.
Dean, Katz School of Science and Health
Vice Provost, Yeshiva University
Professor of Data Science and Information Systems

Utilization of Healthcare Apps for Chronic Conditions: A Market Analysis of WellXcel's Proposed COPD App

Autumn Asen
M.S. in Biotechnology Management and Entrepreneurship

Introduction

In 2020, the COVID-19 pandemic changed many aspects of daily life. With the sudden implementation of isolated lockdown, widespread increase in COVID-19 cases, and cancellation of all non-emergent medical appointments, many individuals became fearful of going to doctors' appointments in person (Mehrotra et al., 2020). This left many people without necessary resources for prevention and management of chronic conditions. Digital health apps provided a promising resolution to help those with chronic conditions access necessary care.

The global digital health market in 2020 was valued at approximately $145 million and is expected to increase by a compound annual growth rate (CAGR) of 17.9% between 2021–2030, reaching approximately $767 million by 2030 (BioSpace, 2022). WellXcel is an educational platform whose goal is to increase the health literacy of its users. WellXcel currently has nine downloadable apps for patients with asthma and diabetes. After witnessing the impact of COVID-19 and the market potential for digital health apps, WellXcel decided to expand and target additional chronic conditions, including Chronic Obstructive Pulmonary Disease (COPD), through apps that can meet patients' needs in getting care remotely. This project aimed to provide a market analysis for WellXcel's planned COPD app.

Strategy

The first step in this market analysis was conducting background research into COPD, including its causes, prevalence, market share, and current COPD-related digital apps. The second step was to conduct a comparative

analysis of existing COPD apps and WellXcel's proposed app. Features considered included app features and costs and whether the app incorporates games, videos or incentives.

Findings

From 2020-2027, the COPD market is expected to increase at a CAGR of 4.5% and reach $25.7 billion (Market Research Future, 2022). The top three COPD-related apps are Propeller, Gold 2021 Pocket Guide, and COPD Manager.

Propeller, which has 1.2K reviews and a rating of 4.7 out of 5 stars, is only accessible after purchase of a $79.99 sensor. The app's main features allow users to set medication reminders, see weather forecasts, track lost inhalers, order medication, find tips on managing symptoms, and track progress.

Gold 2021 Pocket Guide is a free app with 299 reviews and a rating of 4.9 out of 5 stars. Features include COPD and COVID-19 risk factors as well as diagnosis definitions, questionnaires, and management tips.

COPD Manager is also free. It has only 2 reviews and a rating of 3 out of 5 stars. Features allow users to upload medication information, schedule appointments, and journal. The app also includes educational information and a general health questionnaire.

WellXcel's proposed COPD app includes several of the same features as the existing apps, such as medication reminders, risk factors, diagnosis/definitions, questionnaires, journals, and management tips. Unique features include augmented reality (AR), games like word searches and puzzles, interactive videos that portray the disease and its symptom management and warning signs, and incentives in which users can gain points and win prizes by playing games, journaling and watching videos. WellXcel is partnering with other companies to supply gift cards and coupons as prizes. All basic information on WellXcel's app will be free, and a premium option will be available to unlock certain levels of games and large prizes.

Conclusions and Recommendations

WellXcel has the potential to be successful against its competitors, and fo-

cusing on COPD as the next chronic condition is a great decision because the market is expected to continue growing at a steady rate. This means that there will be a large pool of individuals who could benefit from a uniquely designed app that includes interactive features, videos, incentives and an AR component.

For any of its products to succeed in the digital health market, WellXcel's apps must gain recognition, increase user retention, and stand out against the competition. The following strategies could support their success:

- Purchasing sponsored ads on various social media platforms would direct a larger population of potential users to the apps.
- Introducing a premium plan could directly increase profits and raise retention rates. Both free and premium options will allow users to access the same information, interactive videos, and basic games. Premium users could access additional challenges, activities and resources for a monthly fee.
- Partnering with emergency departments could increase awareness of the new apps. App information could be included in discharge papers and in posters and flyers throughout the hospital, and advanced practice practitioners could be trained on how to relay information about the apps during discharge.
- Integrating augmented reality (AR) into each app could attract more users and increase effectiveness. By staging healthcare scenarios in a simulated environment, AR could help users become more aware of the way their disease impacts their body and decrease anxiety about potential treatments (Catchar, n.d.).
- Tracking daily, weekly and monthly active app users could provide important demographic data to support WellXcel's marketing strategies.

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Modeling Complex Grasps Using Muscle Activity of Movement Primitives

Natania Birnbaum
M.S. in Biotechnology Management and Entrepreneurship

Introduction

Eighty percent of stroke survivors lose motor function of the upper limb, which has a detrimental effect on their ability to perform activities of daily living (ADL), further compromising their quality of life (Hu, 2013). Stroke rehabilitation generally involves physical and occupational therapy, which aid recovery over months. However, rehabilitation can be augmented by robot-assisted therapy (Stephenson & Stephens, 2016), which allows patients to undergo repetitive task-based training regimens with little to no supervision in a manner that is less expensive (Wagner, 2011) and increases patient motivation (Rehmat et al., 2018).

Although stroke survivors may not be able to move their muscles, they may still produce weak electrical signals that surface electromyography (sEMG) sensors can detect. A myoelectric exoskeleton controlled by such sensors can be used in upper-limb rehabilitation therapy, which is a form of robot-assisted therapy. The advantages of a sEMG-based approach include ease of data collection, adaptation to the patient's own body movements, and the potential for a more lightweight, flexible and comfortable robot. Robot-assisted therapy for upper-limb functioning using adaptive control strategies can be most effective if tailored to the patient's needs (Lo & Xie, 2012).

The goal of this project was to collect sEMG data from the muscles in the arm involved in controlling the hand and create a model of different hand gestures for a prototype robot. The study aimed to model complex grasps that are useful in ADL using simple movement primitives and to validate the model on a low-cost test bed.

Method

Surface electromyography data was collected from the flexor digitorum superficialis and the flexor carpi ulnaris of one able-bodied participant (23-year-old female), using two Seeed Studios Grove EMG sensors and an Arduino Mega 2560 microcontroller. Five basic movement primitives and 10 grasps were selected from the NinaPro database (Atzori, 2014). Each gesture was performed four times for five seconds each, with three seconds in between trials.

Multiple linear regression was used to analyze the data, using the five movement primitives as weights, to estimate the relative contributions of each primitive to each grasp. As shown in the equation below, each grasp (gr_1) is expressed as a weighted ($w_1 \ldots w_5$) sum of five movement primitives ($ge_1 \ldots ge_5$).

$$gr_1 = w_0 + w_1 ge_1 + w_2 ge_2 + w_3 ge_3 + w_4 ge_4 + w_5 ge_5 + \varepsilon_1$$

Results

Figure 1 shows that primitives 1, 3, and 4 accounted for 86% of the grasp data, and Figure 2 shows that 1 and 3 also had consistently high standard deviation. Gesture 2 has both the lowest variation and lowest contribution (4.3%) across all grasps.

Figure 1

The average weights of each movement primitive for each grasp across all four trials; Zero weight indicates no correlation between gesture and grasp

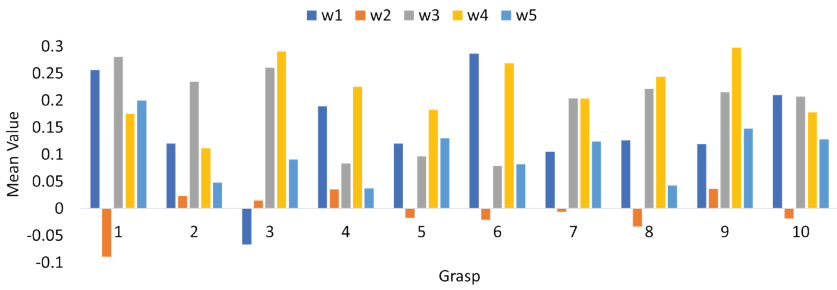
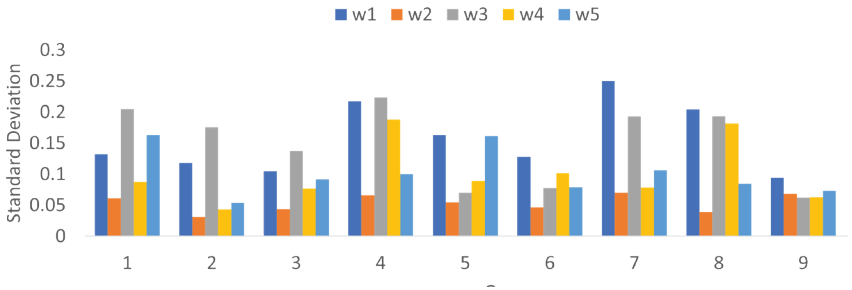


Figure 2

The standard deviation for each grasp across all four trials



Conclusions and Recommendations

The aim of this project was to create effective models of different hand gestures and grasps for an exoskeleton that can be used for upper-limb rehabilitation among stroke survivors. The results show that gestures 3 and 4 appear to contribute substantially to the model in most of the grasps and, therefore, will be the key gestures in future analysis. Gesture 2, on the other hand, has little impact on the model. Seventy percent of the 10 grasps have different mean values for the weights over four trials, which show that the contributions of the movement primitives are inconsistent. This project used only two channels for data collection, which limited the model's accuracy and precision. Data from more locations (channels) and from more subjects, as well as better prediction models such as logistic regression, are likely to improve its accuracy.

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Characterization of Targets Regulated by SUMOylation in Mouse Spermatocytes

Sayanto Pal and Shaye Weinstein
M.S. in Biotechnology Management and Entrepreneurship

Introduction

Infertility affects 48.5 million couples, or 15 percent of the total number of couples worldwide. Approximately 50 percent of these cases are attributed to male partners (Kumar et al., 2015). The stages of adult spermatogenesis include stem cell and spermatogonia proliferation, the meiotic division of spermatocytes, and the post-meiotic maturation of spermatids (also known as spermiogenesis). Understanding the molecular mechanisms that regulate different stages of spermatogenesis is crucial, since aberrant expression of signaling molecules can lead to proliferating or differentiating defects (Vigodner et al., 2020).

Various post-translational modifications (PTM) facilitate spermatogenesis. SUMOylation, a form of PTM by small ubiquitin-like modifiers, or SUMO proteins, has been identified as a critical regulatory mechanism for multiple cellular processes, including sperm development and maturation (Xiao et al., 2016; Vigodner, 2011). The covalent addition of SUMO peptides to other proteins is facilitated through the sequential modification of specific enzymes such as SUMO-activating enzyme (E_1), SUMO-conjugating enzyme (E_2), and cell-specific SUMO ligases (E_3) (Dasso, 2008; Chymkowitch et al., 2015). SUMOylation would be interrupted if any of these enzymes were inactivated (Wilkinson et al., 2010).

This study aimed to identify several proteins essential for spermatogenesis and further unravel their functions and regulation by studying changes in their expression and phosphorylation upon inhibition of SUMOylation by chemical (Ginkgolic acid) and genetic (si-RNA) means. Those targets, in-

cluding Nucleophosmin (NPM), heterogenous ribonucleoprotein H_1 ($hnRNPH_1$), and Valosine containing protein (VCP), were studied using gel electrophoresis and western blotting.

Method

Cell lines: Mouse GC-$_1$ Cell Lines and Primary Cell Lines

The GC-$_1$ cell lines consist of an immortalized cell line intermediate between type B spermatogonia and spermatocytes. The primary cells were obtained by isolating the germ cells from the testes of euthanized mice through enzymatic digestion. The cell lines were grown in DMEM media with 5% fetal bovine serum (FBS, Life Technologies, 6,140e071), 5% bovine growth serum (Fisher Scientific, SH30541.03), 1% penicillin/streptomycin (Life Technologies, 15,140e122), and .5% Fungizone (Life Technologies, 15,290e018) at 32°C and with 5% CO_2.

Ginkgolic acid and si-RNA treatments

Ginkgolic acid (GA) was diluted at 25-150 mM concentrations and then used at different concentrations to inhibit SUMOylation for 2 hours. si-RNAs (Santa Cruz Biotechnology; sc-36773, sc-38551, and sc-36869) were used to inhibit UBC_9, Kap_1, and as a control respectively. The cells were transfected for six hours and were then given a 48-hour recovery time before analysis. The dose of si-RNAs was determined in pilot experiments.

Gel electrophoresis and Western blot

Proteins extracted from the control cells and cells treated with GA and si-RNAs were analyzed using western blotting. Gel Electrophoresis was performed using NuPAGE 4%e12% gradient bis-tris polyacrylamide gels (Thermo Fisher) and MOPS running buffer (Thermo Fisher). The membrane was blocked and incubated with the primary antibodies (ant-SUMO, ant-VCP, ant-NPM and ant-$hnRNPH_1$), followed by the incubation with a secondary antibody. Antibodies against either actin or tubulin were used to confirm equal loading.

Results

Western blot examined VCP's response to GA-inhibited SUMOylation. The VCP regulates nuclear envelope reconstruction, cell cycle, Golgi reassembly, apoptosis suppression, DNA damage responses, autophagosome maturation, and sperm capacitation (Cayli et al., 2010). Results showed GA inhibited SUMOylation and decreased VCP in the western blot (Figure 1). Tubulin verified equal loading. Inhibition was also tested on NPM protein. NPM regulates cell cycle development in somatic cells, but its involvement in germ cells is unknown. Two si-RNAs inhibited SUMOylation. The inhibition significantly reduced the levels of both phosphorylated (upper band) and non-phosphorylated (lower band) NPM isoforms (Figure 2). Equal loading was confirmed by actin. Inhibition's impact on $hnRNPH_1$ was studied similarly. Inactivating $hnRNPH_1$ promotes male infertility by altering alternative splicing during spermatogenesis (Feng et al., 2021). GA and si-RNA inhibited SUMOylation. Inhibition reduced $hnRNPH_1$ expression (Figure 3). Tubulin verified equal loading.

Figure 1

Western Blotting Results of VCP

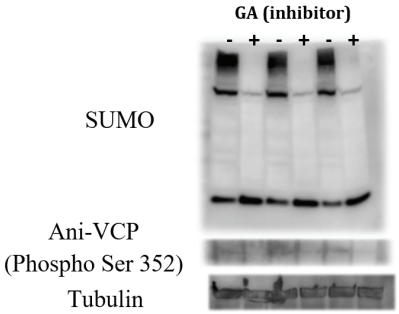


Figure 2

Western Blotting Results of NPM

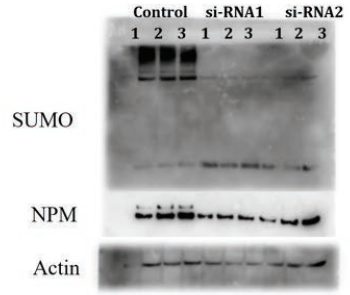
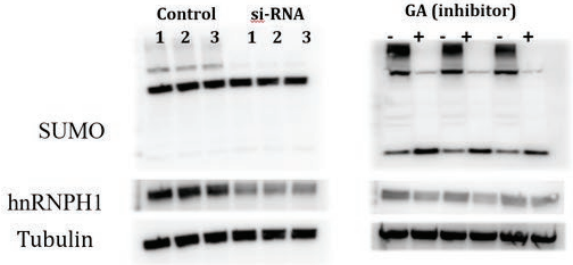


Figure 3

Western Blotting Results of hnRNPH1



Conclusions and Recommendations

When SUMOylation was inhibited, the expression of each of these proteins was downregulated. Actin and tubulin expressions were used to confirm equal loading. Given that these proteins play a crucial role in regulating the cell cycle and spermatogenesis, their downregulation when SUMOylation is inhibited may interfere with the process of spermatogenesis, causing spermatogenic arrest and infertility. Further studies will focus on characterizing these proteins' role in male fertility and their regulation by SUMOylation using mouse models. Once their role is confirmed in the mouse, testicular biopsies from idiopathic infertile patients can be screened for a

possible mutation in these proteins and proteins that regulate their regulation. These data, in turn, will lead to a better understanding of male infertility and the development of new therapeutics.

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Lab to Life: The Path to Successful Biotechnology Commercialization

Anton Papa
M.S. Biotechnology Management and Entrepreneurship

Introduction

Commercializing biotechnology inventions is a critical driver of both economic growth and societal progress, with the potential to improve public health and quality of life. However, important biotechnology inventions often fail to make it to market due to stakeholders facing numerous challenges related to regulatory hurdles, funding constraints, and intellectual property (IP) rights. Albert Einstein College of Medicine's Office of Biotechnology and Business Development (OBBD) is actively involved in finding partners to commercialize biotechnology inventions. In collaboration with OBBD, this project explored the commercialization potential and requirements for three novel biotechnology inventions that have the potential to transform the fields of organ and tissue preservation solutions, Type I diabetes, and precision oncology:

- Project C-00001470: A storage and preservation solution that minimizes damage and prolongs the function of donated biological tissue and organs.
- Project C-00001455: A precision small molecule therapy for patients with Type I Diabetes.
- Project C-00001352: A small molecule cancer therapeutic that targets RICTOR for brain metastasis from lung cancers and overcomes anti-EGFR drug resistance.

This project outlined the commercialization strategy for each technology and provided recommendations into the technology transfer lifecycle for investors, stakeholders, and entrepreneurs interested in the commercialization of biotech inventions.

Strategy

This project focused on the following activities within the technology transfer lifecycle: invention, evaluation, IP protection, and marketing. Figure 1 illustrates the typical Technology Transfer Lifecycle.

The following steps were taken for each of the three technologies under review:

(1) Reviewed IP, invention disclosure information provided by the primary investigator
(2) Drafted non-confidential marketing briefs
(3) Conducted market research and analysis
(4) Identified and recommended potential licensing partners
(5) Drafted marketing campaigns

Figure 1

Technology Transfer Lifecycle (University of Texas, 2020)

Outcomes

Comprehensive marketing briefs were developed for each technology:

Project C-00001470 – In Negotiations

A novel storage and preservation solution that minimizes damage and prolongs function of donated biological tissue and organs

EINSTEIN LEAD INVENTOR: Evripidis Gavathiotis; Richard Kitsis

THERAPEUTIC

BACKGROUND/UNMET NEED

The number of people awaiting organ transplantation in the US alone exceeded 100,000 in 2021. The market demand for suitable donor organs/tissues far outnumbers its supply. The problem is further exacerbated by a lack of compositions and methodologies to preserve and protect the cellular viability and suitability of biological tissue. Besides, the logistics of storing and transporting tissue and organs for transplantation is also a huge limiting factor as well. As a result, these fragile, invaluable human donations of organs and tissues lose viability. Thus, a clear unmet need exists for increasing the shelf-life of donated tissues and organs for transport and transplantation.

SOLUTION

Researchers at Einstein and Yale University teamed together to address the question as to why many donated human organs become unsuitable for transplantation following long cold storage or after a period of warm injury. Using pharmacological and genetic studies, the team for the first time, revealed a role of BAX-mediated cell death as a critical contributing factor for loss of tissue viability and function in *ex vivo* organs and tissues. To translate their finding into clinical application, the team formulated a novel organ/tissue storage and preservation solution. The key components to the formulation were newly discovered first-in-class small molecule BAX activation inhibitors, BAIs. In separate studies, these BAIs were proved to be highly potent in selectively targeting BAX activity in living cells. The team reasoned that BAX being the central regulator of both apoptosis and necrosis, its inhibition will prevent premature tissue and organ damage. Using animal models and human kidneys (deemed unsuitable for transplantation), the team demonstrated that the formulation was highly effective in successfully protecting kidneys from cell death. Most importantly, such protection was evident both during cold storage and after a period of warm injury. Significantly, it was successful in preventing cell death for up to 72 hours of cold storage.

Given the data, the present technology has the potential to substantially increase the time interval during which biological material remains viable and suitable for transplantation.

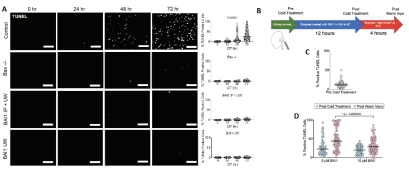

Figure: Bax inhibition abrogates cell death in mouse and human kidneys. (A) Bax inhibition using either using Bax knockout mice or BAI1 supplemented cold preservation solution at time of organ recovery prevents cell death during prolonged cold storage (72 hours) in mouse kidneys. Imaged obtained and quantified after TUNEL staining. (B) Schematic of human organ (kidney) culture model. Quantification of TUNEL positive cells pre-cold treatment (C), post-cold treatment, and post warm injury (D).

APPLICATIONS

- Supports storage and prolongs shelf-life of mammalian cells, tissue, and organs (including all solid and blood related organs)
- Minimizes cell death and improves viability of cells, tissues and organs
- Preserves the biological function of donated tissues/organ
- Enhances transporting abilities with minimal damage to the transported organs.

ADVANTAGES

- Formulation contains first-in-class, potent inhibitors of BAX activation
- Provides ex vivo storage up to 14-day period.
- Potentially supports storage at temperatures ranging from -10 to 37° C.
- Maintains biological activity of stored tissue with minimal cell death (5%) up to a 7-day period
- Potential to overcome long distance transport with minimal damage to transplantable organs

STAGE OF DEVELOPMENT

- Prototype of working formulation developed
- Proof of concept successfully tested in mouse and human kidneys

RELEVANT LITERATURE

- Garner et al, Nature Chemical Biology, 2019

INTELLECTUAL PROPERTY

- US Application No: 16/492,300

Office of Biotechnology and Business Development

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Yale University

Project C-00001455 – Marketed

Novel, precision, small molecule therapy for patients with Type 1 Diabetes

EINSTEIN LEAD INVENTOR: Yaron Tomer

THERAPEUTIC

BACKGROUND/UNMET NEED

Type 1 Diabetes (T1D) is a chronic, autoimmune disorder in which the body's own T-cells mount an immune attack on the insulin producing pancreatic beta cells. This leads to progressive loss and complete depletion of beta cells in an irreversible manner. This causes in most cases complete insulin deficiency and hyperglycemia with its associated complications (e.g., heart disease, renal failure, retinal damage, neuronal damage), requiring patients to survive on lifelong insulin replacement therapy. Even though 1.4 million people in the US have T1D and 30,000 new cases are diagnosed each year, its treatment has not changed much over the last century, and the only therapy available is insulin replacement. Thus, there is an urgent need in the market for more personalized, specific, and targeted immune therapies to cure and prevent T1D.

SOLUTION

Dr. Tomer's team at Einstein, as well as other research teams, discovered that a subset of T1D patients showed a strong association with HLA class-II subtype, HLA-DR3. It is important to note that HLA class-II proteins expressed on antigen presenting cells (APCs) play a major role in presenting beta cells antigens to T cells for mounting immune attack. Around 40% of all patients diagnosed with T1D, harbored the HLA-DR3, allele. Thus, targeting HLA-DR3, provided a strong rationale for therapeutic intervention against onset and prevention of T1D in this subset of T1D patients. The team reasoned that blocking the peptide binding pocket on HLA-DR3 could serve as a potential new therapy in treating the patient group harboring the subtype. The team undertook screening studies to identify potential small molecule drug candidates. In preclinical, *in vivo* proof-of-concept studies in humanized mice expressing HLA-DR3, Cepharanthine proved to be an effective and potent blocker of the HLA-DR3 peptide binding pocket, preventing the activation of auto-reactive T-cells. This novel strategy of patient stratification has the potential to provide excellent treatment outcomes in the target patient group. Besides, as Cepharanthine only targets a specific HLA subtype, all other subtypes of HLA class II molecules that all individuals harbor (e.g. DQ and DP) are expected to continue unperturbed, avoiding a global immune suppression, and not compromising the body's normal immune response to pathogens.

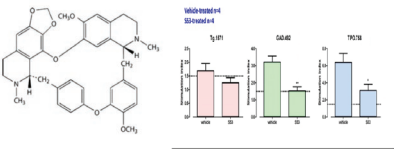

Figure: Chemical structure of Cepharanthine (S53). It is a cyclical plant alkaloid that can be purified from the plant Stephania cepharantha Hayata. NOD-DR3 humanized mice (n=4) were immunized with the 3 peptides (Tg. 1571, TPO. 758, GAD.492) on days 0 and 7. Mice were IV treated with S53 (Cepharanthine) on days -2, -1, 5, and 6 at 1 mg/kg. Mice were sacrificed on day 21 and their splenocytes were stimulated with the peptides used for immunization. Lymphocyte proliferation was determined by CFSE. The Y-axis shows increased stimulation vs. control lymphocytes not stimulated with peptides. S53 (Cepharanthine) significantly suppressed T-cell activation against islet and thyroid autoantigens in treated mice when compared to vehicle-treated controls.

APPLICATIONS

- Treatment, prevention of onset and reduce progression of T1D in patients carrying the HLA-DR3 allele.
- Potential to treat a subset of autoimmune thyroid, Grave's disease in patients carrying the HLA-DR3 allele.
- Potentially can be combined with beta-cell therapy to reverse disease condition.

ADVANTAGES

- First-in-class small molecule therapy.
- Natural plant-based alkaloid.
- Precision therapy.
- Patient stratification increases effective treatment outcomes.
- Potent blocker of HLA-DR3 genotype.
- Drug is known to be well tolerated in patients.
- Potentially reduces off-target effects as it spares all other HLA subtype.

STAGE OF DEVELOPMENT

- Preclinical studies completed *in vitro* mouse model

RELEVANT LITERATURE

- Haller, et al. Endocrinology. 2010
- Li et al. J Autoimmun 2021

INTELLECTUAL PROPERTY

- PCT/US2022/039029

Office of Biotechnology and Business Development

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Project C-00001352 – Marketed

Targeting RICTOR for brain metastasis and overcoming anti-EGFR drug resistance

LEAD INVENTOR: Haiying Cheng

THERAPEUTIC: SMALL MOLECULE

BACKGROUND/UNMET NEED

An estimated 20 - 50% of lung cancer patients advance to brain metastasis. Besides, lung cancer patients with EGFR mutation subsequently develop resistance to its targeted therapy. Currently, no effective treatment regimens are available to reverse drug resistance to EGFR inhibition therapy and to prevent brain metastasis from NSCLC.

SOLUTION

Dr. Cheng and her team have identified RICTOR (Rapamycin-insensitive companion of mammalian target of rapamycin) as a new therapeutic target for treating brain metastasis resulting from primary tumors including lung cancer. RICTOR is a key component of the PI3K/AKT/mTORC2 pathway, which mediates cell homeostasis and cell survival in tumor growth and metastasis. Using genomic sequencing data from 11,845 lung adenocarcinoma patients, the team made the pioneering discovery showing pronounced RICTOR gene amplification in the brain metastasis. The discovery led to further unraveling of links between RICTOR signaling and development of drug resistance to EGFR, ALK or MED inhibitor therapy in a subset of lung cancer patients. In their effort to target RICTOR the team undertook an extensive screening to identify inhibitors. As a proof of concept, genetically or pharmacologically induced RICTOR ablation in in vitro and in vivo mouse model was performed. To this end, the tested RICTOR inhibitors showed a significant reduction of tumor growth and brain metastasis. This technology has potential to serve as a novel cancer therapeutic target to fight brain metastases and to overcome in a subset of EGRF, ALK or MET inhibitor resistance.

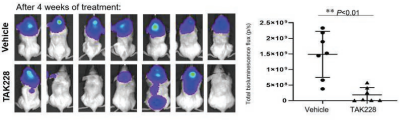

FIGURE: (Left panel) In vivo metastasis assays using the stereotactic brain injection models. After 4 weeks of daily oral gavage, TAK228 (RICTOR inhibitor) significantly reduced tumor growth in the brain, including 43% (3 out 7) near complete responses. (Right panel) Quantification of tumor growth of the in vivo study by measuring total bioluminescence flux.

APPLICATIONS

- Potential treatment and prevention of brain metastasis resulting from lung cancer and other primary tumors
- Potential to overcome resistance to a subset of EGFR, ALK or MET inhibitor therapy

ADVANTAGES

- Novel target
- Target validated using genomic data from 11,845 human patients with lung adenocarcinoma.
- Orally administered small molecule inhibitors
- Potential combination therapy with EGFR inhibitor

STAGE OF DEVELOPMENT

- Preclinical stage
- Actively screening and optimizing RICTOR-specific inhibitors

RELEVANT LITERATURE

- Cheng H et al. Cancer Discovery, (2015)

INTELLECTUAL PROPERTY

US Patent Application::

- 62/958,427

[https://patentscope.wipo.int/search/en/detail.jsf?docId=US329765892&tab=NATIONALBIBLIO&_cid=P12-KUEFS6-22150-1]

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Conclusions and Recommendations

This project provided commercialization strategies for three technologies: an organ and tissue preservation solution, a small molecule therapy for Type I Diabetes, and a small molecule therapy for lung cancer. The organ and tissue preservation solution technology is currently being negotiated for licensing with partners identified by the primary investigator. The technology has been validated on human organs and tissues and is expected to make a significant difference, prolonging the life and function of donated organs and tissues. The small molecule therapeutics for Type I Diabetes and metastatic lung cancer have been marketed to potential licensing partners with high expectations of being licensed. Both technologies have been preclinically validated using in vivo and in vitro mouse models, demonstrating very promising results.

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Market Analysis of Advanced Magnetic Resonance Imaging Post-Processing Software MedImageMetric (MIM)

Rebecca Russo-Schlossberg
M.S. in Biotechnology Management and Entrepreneurship

Introduction

Medical imaging has become extremely data-intensive, and much of the data collected from MRI scans—including phase, echo series and tracer series data—is unused (Turner et al., 2003). MedImageMetric (MIM), an MRI post-processing software company, develops quantitative imaging products for precision diagnosis and treatment, specifically of the brain. MIM developed four products to reconstruct unused MRI data using mathematics and physics to inform diagnosis and treatment for various clinical indications (Wang et al., 2017). Their first product, QSMetric™, is approved, while their other three, OEFMetric™, QTMetric™ and QSM-Medi™ are in the pipeline.

The MRI post-processing market is growing exponentially, expected to reach $1.9 billion by 2026, growing at a CAGR of 8.2% (IndustryARC, 2023; Allied Analytics, 2023). This is driven by an increase in the use of MRI in clinical contexts, the number of procedures utilizing MRI, adoption in emerging markets and education on the value of post-processing software (Markets, 2021). MIM has enormous earnings opportunity within this market, assuming they follow a meticulous sales strategy. This project entailed a thorough market analysis and financial modeling to determine the most appropriate sales strategy for MIM.

Strategy

To determine the appropriate sales strategy for MIM, a thorough market analysis and financial model were developed. The market analysis and fi-

nancial model were informed by interviews with experts from the radiology and post-processing fields, extensive review of the literature, data collection from the internet, feature selection, exploratory data analysis, financial modeling and proprietary MIM materials.

The first step was to determine MIM's potential sales channels and customers. Next, to identify the appropriate sales strategy and optimal price, a 10-year financial model was created for each sales channel reporting top-line revenue; operating costs; earnings before interest, taxes, depreciation, and amortization (EBITDA); and bottom-line revenue. Finally, profitability, growth, sensitivity and efficiency analyses were conducted to compare the four channels and identify the first two channels to pursue.

Outcomes

The following independent sales channels were identified for MIM, with vast differences in market access, operating costs, potential revenue and realized earnings:

- Sublicensing to Original Equipment Manufacturers (OEM)
- Selling via the App Store through OEMs
- A multiyear license agreement or a perpetual license agreement via post-processing and surgical planning vendors
- A multiyear license agreement or a perpetual license agreement via direct-to-consumer (DTC)

The financial model identified that the OEM and App Store channels earn the most over a 10-year period at the target price of $30,000, indicating that those would be the channels to pursue (Figure 1). However, expert interviews reported that the App Store is still a very new and evolving idea, so much so that only two of the larger OEMs, GE and Philips, have developed one. This presents a risk for MIM and thus encourages them to stick with the OEM channel as their initial sales strategy. OEM also had the lowest operating costs and second-highest revenues (Figures 2 and 3).

Figure 1

Average Earnings

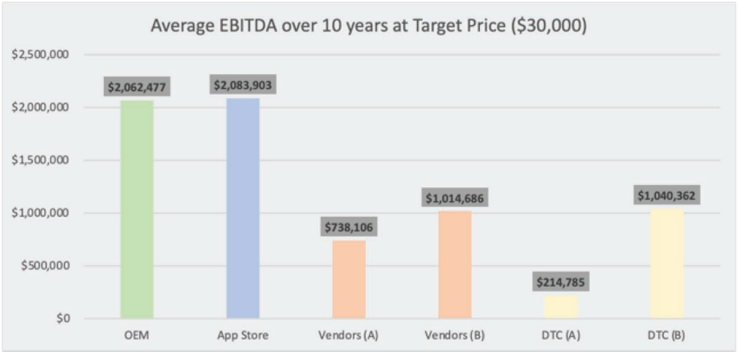


Figure 2

Average Revenue

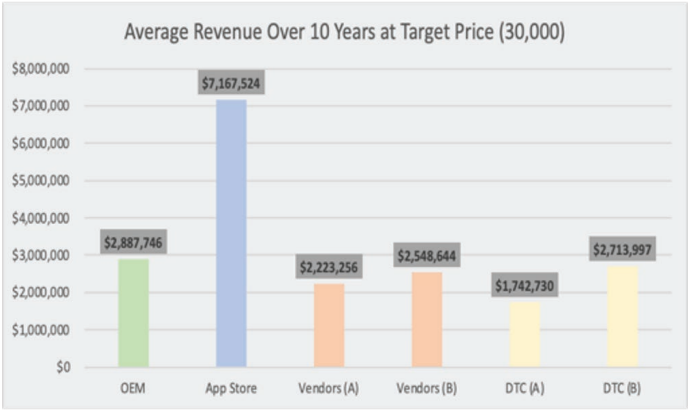
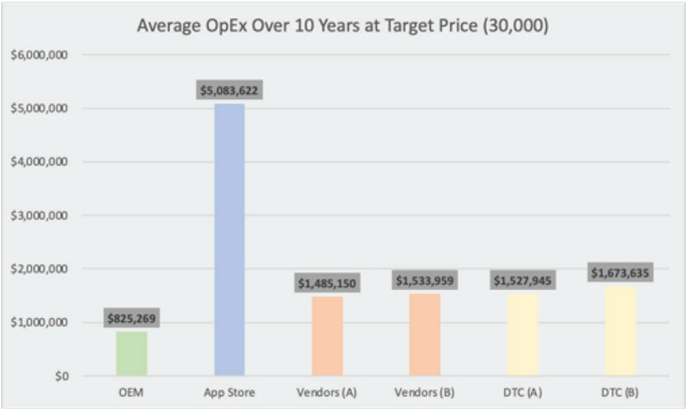


Figure 3

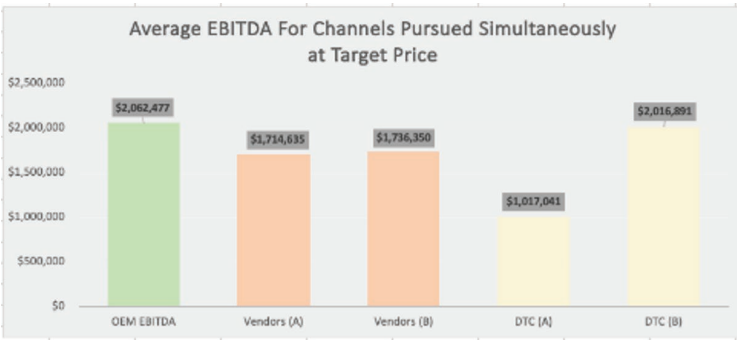
Average Operating Costs



Additionally, OEM was the only channel that had consistently increased revenues, whereas the vendor and DTC perpetual license channels had significant drops in revenue over time due to saturation of the market. Those channels are smaller in nature and thus do not offer MIM as much potential. However, once the operating expenses are covered by the OEM channel, the second channel presenting opportunity is the perpetual license DTC (B) channel (Figure 4).

Figure 4

Average Earnings for Channels Pursued Simultaneously



Conclusions and Recommendations

The recommended sales strategy is the OEM IP sublicense first and then the DTC (B) channel. OEM had the lowest operating costs and second-highest revenues because sublicensing the IP to the OEMs places the burden of development, regulatory clearance, marketing and sales on the OEMs, while giving MIM global access to their customers from new sales of MRI machines and from their installed base. This would enable MIM to generate profit from their OEM IP sublicenses while increasing brand awareness through grassroots relationships and proving clinical applicability in published research from their DTC channel. Another area of opportunity is App Store, currently considered a non-OEM channel and therefore subject to the WCH 15% IP royalty. If MIM could restructure their deal with WCH to consider the App Store an OEM channel, AppStore would be subject to only a 4% IP royalty and would thus become the potentially most lucrative channel.

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Navier-Stokes Numerical Simulation of Vortices in the Compressible Gas Flow

Ellie Austin
Ph.D. in Mathematical Sciences

Introduction

Compressible gas flow is of great importance for both theoretical and applied science. The aim of this study was to develop a numerical modeling of the vortex structure of the Couette-Taylor flow for a compressible gas flow in a wind tunnel, depending on Reynolds numbers and cylinder surface temperatures applying the Navier-Stokes equations and using ANSYS CFX software package.

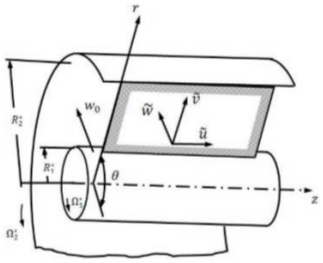
The Navier-Stokes equations are at the heart of fluid flow modeling. They describe the physics of many phenomena of scientific and engineering interest, which can be useful to model the weather, ocean currents, water flow in a pipe and air flow around a wing, as well as in design of aircraft, spacecraft, vessels and cars, the study of blood flow, the design of power plants, and the analysis of pollution (Marini & Otway, 2013; Uhlenbeck, 2001). Solving them, for a particular set of boundary conditions, such as inlets, outlets, and walls, helps predict the fluid velocity and its pressure. Navier-Stokes equations are partial differential equations which describe the motion of viscous fluid substances and mathematically express conservation of momentum and conservation of mass for Newtonian fluids (Otway, 2001). They were derived independently by French engineer and physicist Claude-Louis Navier and Anglo-Irish physicist and mathematician George Gabriel Stokes and developed over several decades, from 1822 (Navier) to 1842–1850 (Stokes). This study explored numerical modeling of the vortex structure to produce numerical solutions for various values of the surface temperature of the cylinders and the speeds leading to the formation of vortices.

Method

The flow between two concentric cylinders in a wind tunnel was investigated. The cylinders were of infinite lengths and rotated at different angular speeds (Otway, 2000; 2012). It was assumed that cylinder surfaces had different temperatures. A cylindrical coordinate system was introduced for a steady stream of compressible viscous fluid. The gas flow between two coaxial cylinders was supported by constant angular velocity of one or both cylinders without an average axial flow (the average axial flow direction was zero) (Figure 1).

Figure 1

Physical and numerical models of the gas flow



Coordinates: (x,y,z)
Velocity Components: (u,v,w)
Time: t Pressure: p
Density: ρ Stress: τ
Total Energy: Et
Heat Fluxc q
Reynolds Number: Re
Prandtl Number: Pr

Continuity:
$$\frac{\partial \rho}{\partial t}+\frac{\partial(\rho u)}{\partial x}+\frac{\partial(\rho v)}{\partial y}+\frac{\partial(\rho w)}{\partial z}=0$$

X – Momentum:
$$\frac{\partial(\rho u)}{\partial t}+\frac{\partial(\rho u^2)}{\partial x}+\frac{\partial(\rho uv)}{\partial y}+\frac{\partial(\rho uw)}{\partial z}=-\frac{\partial p}{\partial x}+\frac{1}{Re_r}\left[\frac{\partial \tau_{xx}}{\partial x}+\frac{\partial \tau_{xy}}{\partial y}+\frac{\partial \tau_{xz}}{\partial z}\right]$$

Y – Momentum:
$$\frac{\partial(\rho v)}{\partial t}+\frac{\partial(\rho uv)}{\partial x}+\frac{\partial(\rho v^2)}{\partial y}+\frac{\partial(\rho vw)}{\partial z}=-\frac{\partial p}{\partial y}+\frac{1}{Re_r}\left[\frac{\partial \tau_{xy}}{\partial x}+\frac{\partial \tau_{yy}}{\partial y}+\frac{\partial \tau_{yz}}{\partial z}\right]$$

Z – Momentum
$$\frac{\partial(\rho w)}{\partial t}+\frac{\partial(\rho uw)}{\partial x}+\frac{\partial(\rho vw)}{\partial y}+\frac{\partial(\rho w^2)}{\partial z}=-\frac{\partial p}{\partial z}+\frac{1}{Re_r}\left[\frac{\partial \tau_{xz}}{\partial x}+\frac{\partial \tau_{yz}}{\partial y}+\frac{\partial \tau_{zz}}{\partial z}\right]$$

Energy:
$$\frac{\partial(E_T)}{\partial t}+\frac{\partial(uE_T)}{\partial x}+\frac{\partial(vE_T)}{\partial y}+\frac{\partial(wE_T)}{\partial z}=-\frac{\partial(up)}{\partial x}-\frac{\partial(vp)}{\partial y}-\frac{\partial(wp)}{\partial z}-\frac{1}{Re_r Pr_r}\left[\frac{\partial q_x}{\partial x}+\frac{\partial q_y}{\partial y}+\frac{\partial q_z}{\partial z}\right]$$
$$+\frac{1}{Re_r}\left[\frac{\partial}{\partial x}(u\tau_{xx}+v\tau_{xy}+w\tau_{xz})+\frac{\partial}{\partial y}(u\tau_{xy}+v\tau_{yy}+w\tau_{yz})+\frac{\partial}{\partial z}(u\tau_{xz}+v\tau_{yz}+w\tau_{zz})\right]$$

In numerical simulation, the length of the cylinders was specified under the assumption that it significantly exceeded the radii of the cylinders. The mesh was built using the ANSYS CFX software package. The grid was structured, containing more than 2 million cells. The calculations were also performed using ANSYS CFX. The flows considered were simulated using the Navier-Stokes equations written in cylindrical coordinates. The calculation used the turbulence model SST (Shear Stress Transport) under the assumption that gas was perfect.

Results

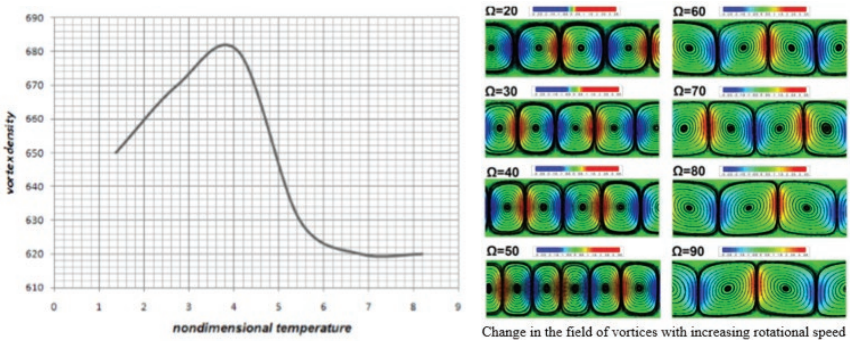
An analysis of the results showed that when the Reynolds number changed from $4x10^4$ to $4x10^5$, the number of pairs of vortices varied in accordance

with the curve shown in Figure 2. At Re = 41583.05, the field was stationary and did not contain vortices. With Re < 20x10⁴, the number of vortex pairs increased monotonically with increasing Re. Within the range of Reynolds number changed from 20x10⁴ to 30x10⁴, the number of vortices decreased rapidly. After that, it remained almost constant, although the Reynolds number continued to increase. When Re > 30x10⁴, the flow became unsteady. Vortex pairs changed their shape and became asymmetric. With a change in temperature of the external cylinder, the velocity field remained stationary, and the vortex pairs formed periodic structure and density of vortex pairs (number of vortex pairs per one-meter section of the cylinder) varied slightly.

First, when $\overline{T} \leq 4$, the number of pairs increased monotonically with increasing temperature. After that, it decreased and finally stabilized when the temperature reaches $(\overline{T}) \geq 7$ (Figure 2).

Figure 2

Change in vorticity with increasing temperature and rotational speed



Change in the field of vortices with increasing rotational speed

Conclusions and Recommendations

The Couette-Taylor viscous flow of a compressible gas in a wind tunnel was studied by numerical methods. Based on the physical model of the vortex structure of the Couette-Taylor flow for a compressible gas flow in a wind tunnel, numerical results were obtained for different surface temperatures and angular velocities of cylinders. The influence of these parameters on the density and structure of vortices in the flow was investigated. The non-

monotonic dependency of the number of vortices (or the sizes of vortices in the circumferential direction) on the Reynolds number and on the surface temperature of the outer cylinder was identified.

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Constructing Triangle Method to Solve Trigonometric Differential Equation

Xingyu Liu
Ph.D. in Mathematical Sciences

Introduction

Trigonometric differential equations are ubiquitous in many branches of mathematics and science, including physics, engineering and economics. They often arise in problems involving periodic phenomena, such as oscillations and waves, and have a wide range of applications. One method that has been used to solve trigonometric differential equations is the Constructing Triangle Method (CTM). CTM is a geometric method that involves constructing a right-angled triangle to represent the given trigonometric function and its derivatives. This method has been shown to be a powerful tool for solving complex trigonometric differential equations, reducing the problem to a simpler geometric problem.

This study explored the use of the Constructing Triangle Method (CTM) to solve a trigonometric differential equation by 1) solving the trigonometric differential equation du/dt = cosu(t), and 2) comparing the solutions obtained by CTM with those obtained by other methods, such as separation of variables, substitution, and integrating factors.

Method

1. By separation, we have $\int 1/\cos u \, du = \int t/_0 \, dt$, solve this integration we have $||\tan u(t) + \sec u(t)| = e^t |\tan 1 + \sec 1|$
2. To extract $u(t)$ out as an angle, we expressed $|\tan u(t)| + \sec u(t)| = |(y+z)/-x|$ so that $|\tan u(t) + \sec u(t)|^2 = |(y+z)/-x|^2$ From here we set $x^2 = -2yz$ so then the rational function inside the absolute value sign it satisfies the Law of Cosine Theorem. We have $\sin u(t) = \cos(\pi - u(t)) = e^{2t}|\tan 1 + \sec 1|$, and finally the answer is $u(t) = \arcsin(e^{2t}|\tan 1$

+ sec 1|2).

3. In the process to compute, we have set $x^2 = -2yz$, which manifests the triangle exists in an inner product space. There are six possibilities for signs of (x,y,z), it could be proved case by case that all possibilities would be rejected except $x = i\sqrt{2}yz$. We confirm the triangle exists in a Riemann surface.

Outcomes

As we have derived the solution $u(t)$ is in the form of *arcsin*, images (a) and (b) below show how the inverse of sine looks in Riemann surface.

(a) Real part of inverse sinz

(b) Imaginary part of inverse sinz

From the above analysis, the solution of this trigonometric differential equation is an angle in upper half plane in complex coordinate, so that the solution $u(t)$ is a complex number.

Conclusions and Recommendations

The significance of this study lies in its potential to provide a valuable tool for students and researchers to solve complex trigonometric differential equations with ease and confidence. CTM reduced the complexity of the problem and provides a clear geometric interpretation of the solution. Overall, the study provides a deeper understanding of the use of CTM in solving trigonometric differential equations and may contribute to the development

of new and innovative techniques for solving trigonometric differential equations, which can have practical applications in many fields.

Magnetic Permeability Measurements from Magnetic Resonance Imaging (MRI)

Yonathan Magendzo
B.A./M.A. in Physics

Introduction

The detection of traces of iron in the brain is useful for medical applications. Different tissues possessing different magnetic permeabilities expose themselves via small spatial variations of the magnetic field during magnetic resonance imaging (MRI) (Shmueli et al., 2009; Duyn & Schenck, 2017). Data acquisition and image analysis methods that visualize spatial distributions of magnetic permeabilities are known as quantitative permeability mapping. However, since most modern techniques of MRI model the brain as a collection of magnetic dipoles, only the longitudinal component of the magnetic field is assessable to MRI (Brown et al., 2022). But as the permeabilities can only be known by measuring all the components of the magnetic field, an MRI machine cannot determine the magnetic permeabilities of the brain tissues. This research aims to determine the permeabilities by measuring just the longitudinal component of the magnetic field inside the MRI machine.

Method

To find the permeabilities of the brain tissues without needing to obtain information on all the components of the magnetic field inside the MRI machine, we developed a model and algorithm that extracts the longitudinal component of the magnetic field and determines the permeabilities. The algorithm does this in three steps. First, the forward magnetostatics problem is solved numerically using a sample brain for a trial permeability map. Second, this numerical solution is compared with real measurements of the longitudinal magnetic field of an MRI with that same sample brain. Third,

the permeabilities are found by performing a least squares optimization method.

Due to the uniformity of the magnetic field and the absence of eddy currents, the relaxation method is applied using Maxwell's equations in order to solve the forward magnetostatic problem. The boundary conditions are set to a uniform magnetic field pointing along the axis of the main MRI magnet sufficiently far away from the head for minimum field distortion caused by the brain tissues. From this 3D potential field, the vector magnetic field is obtained by taking the gradient. Finally, only the longitudinal component of that magnetic field is considered for comparison with the measured data.

The longitudinal component of the magnetic field obtained from the MRI experiment is used to fit the magnetic permeabilities of the materials inside the brain by fitting the computational results to the MRI data. The algorithm considers a least-square cost function that floats the permeability parameters until a minimum of the cost function is found.

Results

We have successfully simulated the magnetic field inside an MRI machine, and we can study local distortions in the magnetic field by introducing different magnetic permeabilities in different pixels. The advantage of our method is that it is transparent and completely well-defined so that its use and improvements can be measured. We are also able to produce images of the distortions of the magnetic field for visual help and analysis (see Figure 1). Figure 2 illustrates the magnetic field produced using the permeabilities that gave a minimum cost function.

Figure 1

Example of a slice of such 3D computation with realistic values of magnetic permeability for cerebrospinal fluid, white matter, and gray matter.

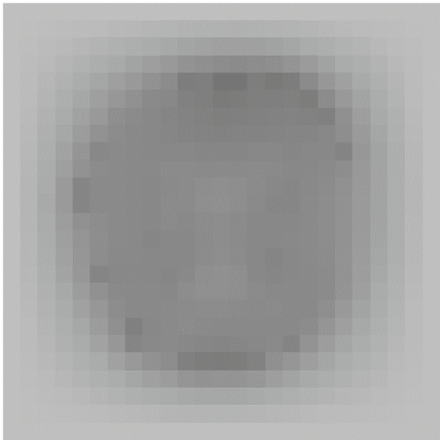
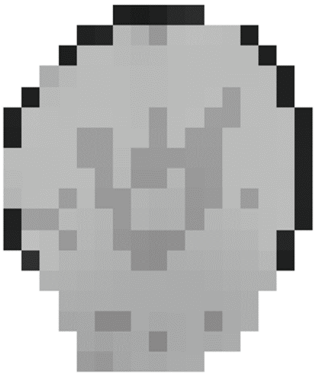


Figure 2

Example of the magnetic field produced using the susceptibilities that gave the minimum.



Conclusion

In this work, we have shown that a computer algorithm comprising a direct solution of the magnetic problem inside an MRI and a least-square minimization provides a novel approach to measuring small permeabilities in the brain. For now, we have made a proof of concept; we have found permeabilities of the brain tissues that give a local minimum to the cost function. We are currently testing the numerical results of the magnetic field with theoretical solutions. In the future, we hope to find a global minimum in the cost function and develop a user-interface algorithm to be implemented in modern MRI machines.

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Numerical Explorations in the Non-Linear Schrodinger Equation with Non-Symmetrical Gaussian Initial Conditions

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Introduction

The Non-Linear Schrodinger (NLS) equation $-i\,\partial\psi/\partial t + \frac{1}{2}((\partial^2\psi)/(\partial x^2)+(\partial^2\psi)/(\partial y^2))+f(|\psi|^2)\psi=0$ is a nonlinear partial differential equation (PDE) with physical applications in optics, fluid flow, and other fields. A common application is to beams of light. When $f(|\psi|^2)=|\psi|^2$ the beam will self-diffract if the power falls below the critical power and will self-focus until collapse if above the critical power. This case is termed "Kerr non-linearity."

Instead, we focused on saturated non-linearity, with $f(|\psi|^2)=(|\psi|^2)/(1+\gamma|\psi|^2)$. In particular, we focused on the case of two transverse dimensions (x,y; spatial dimensions) against the dimension of propagation (expressed in the equation as t, the time dimension; this is the third spatial dimension z). Saturated non-linearity acts as a limitation on the nonlinear component of the equation to prevent it from blowing up as it ($|\psi|$) grows. Ultimately, we collected data regarding the behavior of a Gaussian approximation of the solution to the NLS.

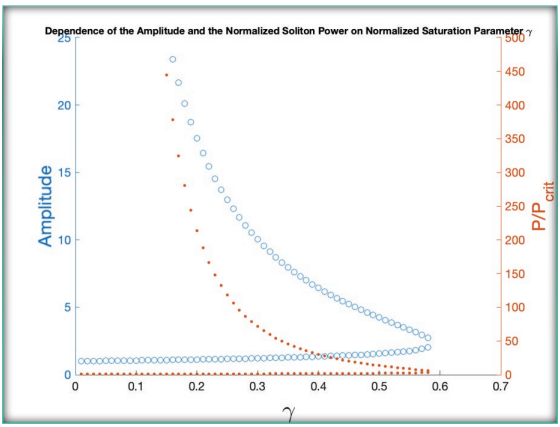
Method

Following the method laid out by Gatz and Herrmann (1997) to solve for the spatial solution to the NLS, we applied their iterative method to solve for the initial conditions (IC) of this PDE given our chosen parameter (γ) and constraints. We replicated data and figures from this paper in order to en-

sure our replication was sound. The methodology was to run through a range of possible ρ_0 for each γ and to observe and pick the values which fulfill the constraint $\rho_1=½\ \rho_0$. Most γ values have two corresponding ρ_0 which fulfilled the constraint. We used these ρ_0 values to find ρ vectors, which serve as the IC for this equation. Such an IC physically corresponds to the initial state of the beam, which we use as a basis to step forward in time and approximate the development of the beam (Figure 1).

Figure 1

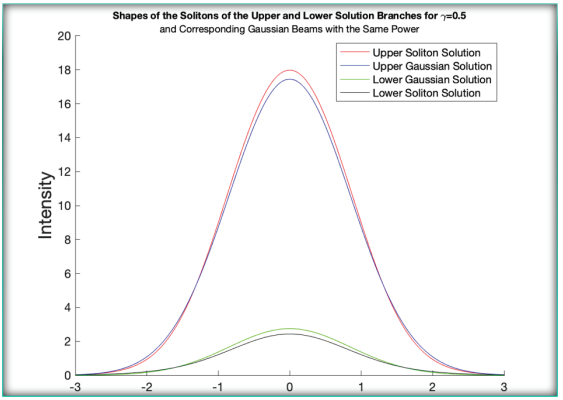
Dependence of the Amplitude and the Normalized Soliton Power on Normalized Saturation Parameter



Subsequently, we plugged our IC (p) into a split-step method to step forward in time and approximate the stationary solution $\psi=e^{i\beta t}\ f(x,y)$ to our PDE for any given time. We obtained the power of the beam from our soliton solution and constructed a Gaussian function of two dimensions whose power is equivalent to the power of the solution (Figure 2). We ran the split-step method on the Gaussian approximation, plugging in different values for variables which affect the symmetry of the beam, as well as the relative widths of the Gaussians.

Figure 2

Shapes of the Solutions of the Upper and Lower Solution Branches

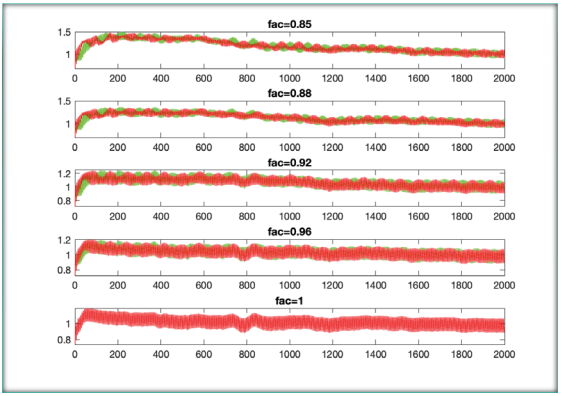


Results

We obtained data for 96 unique beams from our split-step simulations of Gaussian approximations. These data describe how the amplitude and widths (in both dimensions) changed in any one beam over time. We observed that there are two internal modes relating to the widths of the beams (Figure 3). To further analyze this data, we automated a process to take Fourier transforms of the amplitude and widths and collected information concerning their frequencies. These data are awaiting analysis.

Figure 3

Behavior of the Widths of Gaussian Beam



Conclusions and Recommendations

We observed two internal modes relating to the widths of the beams, as well as interesting patterns that occur in the amplitude and widths as they change in the beam over time. Further analysis must be done on the latter finding, which will inform future research. Further research would also involve running the codes with finer steps; we used 512 points on our intervals but are interested in running the codes for 1024 and 2048 points.

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This research was conducted under the guidance of Professor Jeremy Schiff, Bar-Ilan University, as part of the Yeshiva University/Bar-Ilan University Summer 2022 Research Internship Program and was originally published in the YU/BIU Summer 2022 Abstract Book.

Forgive but Don't Forget: Lessons Learned from the Paycheck Protection Program

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Introduction

During periods of economic crisis, the government may issue bailout loans and stimulus checks, such as the Paycheck Protection Program (PPP) issued by the U.S. Small Business Association (SBA) to assist small businesses impacted by the COVID-19 pandemic. PPP was intended to assist small businesses and preserve jobs by giving loans at the low interest rate of 1% and a maturity of either two or five years. At the time of writing, the SBA has granted forgiveness to 85% of applicants, totaling over $100 billion. Bailout loans experience an usually low rate of being paid back, and the burden of this economic strain ultimately falls to the taxpayer (Jackson, 2023).

While there are currently studies and predictive analyses on PPP, no study to date has attempted to predict the level of forgiveness requested on these loans. The aim of this study was to identify a connection between different loan factors and levels of forgiveness, to create a new underwriting model for government-assisted loans. Specifically, the study considered the two biggest deficiencies of the PPP: the high forgiveness amount and the high levels of fraud.

Method

This study used data from the SBA (2023), which contained attributes of each loan, including borrower information, information on the servicer and lender, loan amount and the amount of forgiveness applied for. The data was used to create a response variable to standardize levels of forgiveness across loans, called the ForgivenessRatio, which divides the amount of forgiveness applied for by the loan amount and allows comparison between small and large loans.

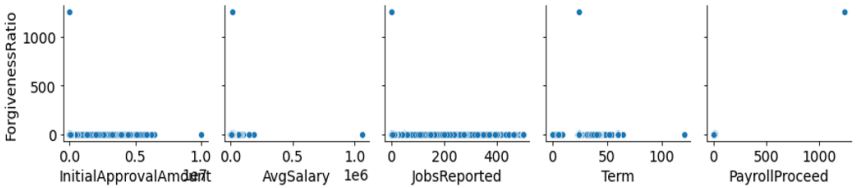
A second variable called ForgivenessLevel was created to allow for classification analysis. The measure accounted for different classes of forgiveness levels, classifying the loans as either low, medium or high risk. Several other variables were created to compare different loans such as the percentage of dollars used for salary purposes and the average salary for each company. Detailed analysis was conducted on the loans that were classified as low risk, including an examination of trends in the industry of each business in that category.

Results

No linear relationship was discovered between the numeric predictive variables (Figure 1), indicating that this problem is better fitted for classification algorithms such as K-Nearest Neighbors (KNN), Random Forests, Voting Ensembles, and various boosting methods.

Figure 1

Relationships Between Numeric Predictors and ForgivenessLevel



While the classification model had great success, achieving accuracy scores as high as 91% using the Random Forest model, the null error rate was approximately 91% (Table 1). This means that the results were no more accurate than randomly guessing that each loan was medium risk.

Table 1

Distribution of Risk Levels Among Entire Data Set

ForgivenessLevel1	
medium	90.7%
low	9.0%
high	0.3%

One of the commonly occurring medium-risk industries was healthcare, while one of the lowest-risk industries was warehousing & transportation (Table 2).

Table 2

Industry Trends Among Different Risk Levels

Risk Level	Industry	Reason
Medium	Healthcare	Overloaded medical system
Low	Warehousing/ Transportation	Thrived from rise of online shopping under quarantine

Fraud was also a significant factor and shortfall of PPP, with many companies pocketing funds intended for employees (Dilanian & Strickler, 2022). Several factors contributed to widespread fraud (Arnold & Porter, 2023):

- requesting funds under the name of other businesses.
- exaggerating income and number of employees to get larger loans.
- loose requirements for getting a loan due to urgency for government assistance.
- underregulating alternative lending sources like fintech (Fast & Pfeiffer, 2022).
- loan applications not being properly scrutinized (Fast & Pfeiffer, 2022).

Conclusions and Recommendations

This study aimed to identify a connection between different loan factors and the level of forgiveness in loans given through the PPP program. Findings suggest that regulatory agencies like the SBA need to tighten their lending requirements, and the federal government needs to apply more oversight to certain lending bodies in order to prevent fraud and decrease forgiveness.

To prevent fraud, lenders must strengthen underwriting requirements to ensure that loans are granted to legitimate businesses, properly scrutinize

applications, and regulate fintech companies and alternative lenders. Outcomes of the PPP are still fresh. As more data become available, further studies with advanced data manipulation techniques could help researchers identify specific patterns in fraudulent cases.

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Play and Arts-Based Program to Increase Social Skills and Self-esteem of Children with Autism Spectrum Disorder

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Introduction

Children with autism spectrum disorder (ASD) have difficulty with social communication, which often decreases their motivation to interact with peers (Frye, 2018). Additionally, children with ASD report lower self-esteem than their typically developing peers, which can lead to co-occurring disorders such as anxiety and depression (Van Der Cruijsen et al., 2020). An increase in social skills and improved emotional regulation have been shown to result in social competence among children with ASD, as well as decreased anxiety in social interactions (Dekker et al., 2019).

The aim of this project was to develop an evidence-based program to increase self-esteem and social skills of children aged 7–9 with ASD using play and expressive arts as the two main mediums. Engaging in play and expressive arts are two evidence-based practices for children with ASD, enabling children to engage in a fun activity while increasing their social-emotional, cognitive, motor, and communication skills (Gibson et al., 2021). Furthermore, "Play is a primary occupation for children; it provides children with the opportunity to socialize with others" (American Occupational Therapy Association, 2020, p. 35). Studies also show that programs aimed to increase the social skills of children with ASD have also increased their self-esteem (Pordanjani, 2021).

Strategy

A literature review was performed to determine:

- Self-esteem and social skills among children ages 7–9 with ASD.
- Specific areas in which children ages 7–9 with ASD have difficulty maintaining social skills and positive self-esteem.
- Evidence-based practices used for children ages 7–9 with ASD.

The findings of the literature review informed program development, with the following consideration: How can each session (i.e., emotional expression) incorporate evidence-based practices that directly related to self-esteem and social skills of children ages 7–9 with ASD?

Outcomes

A group-based program was developed, consisting of six, 60-minute sessions aimed at increasing the social skills and self-esteem of children ages 7–9 with ASD. Session topics focused on areas in which children ages 7–9 with ASD struggle most when it comes to interacting with peers and maintaining relationships (Yeo & Teng, 2015): coping with sensory needs, emotional expression, emotional recognition, initiating conversations and stress management.

Group-based program session structure:

- Opening: Greeting to provide support for initiating social interactions with peers (Sautter, 2020).
- Introduction to the session topic: Using visual aides to support children's level of communication.
- Warm-up meditation activity: Increasing children's level of attention on the present moment, which can help children maintain conversations with peers (Hourston & Atchley, 2017).
- Main activity: Encouraging social skills development through videos, social stories and role play while engaging in evidence-based practices, specifically using play and the expressive arts.
- Application: Practicing the tools and strategies taught in the lesson.
- Closing: "One-minute goodbyes" to inform social skills development (Sautter, 2020).

Conclusions and Recommendations

This educational program focused on enhancing social skills and self-esteem of children with ASD using play and expressive arts. While the program was not conducted due to time constraints, the program can be incorporated by occupational therapists when working with children of this population. Eventually, it can be modified based on the needs of younger or older children with ASD, and similar programs can be created relating to other areas of life, such as activities of daily living.

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An Interactive, Child-Development Storybook for Jewish Parents

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Introduction

The Centers for Disease Control and Prevention (CDC) urges parents to monitor early signs of developmental delay in their children, as early detection is crucial for a child's future development and access to necessary services (CDC, 2022). Although the CDC offers educational tools for parents, they are inaccessible to certain communities, including the insular ultra-Orthodox Jewish community, which limits access to secular media sources (Pirutinsky et al., 2015). Therefore, there is a need for an accessible tool to educate ultra-Orthodox Jewish parents about the updated CDC developmental milestones.

The purpose of this project was to create an engaging children's book, which would contain a primary story for parents to read to their 2-year-old child and a secondary narration with information and strategies for parents to support their child in achieving developmental milestones. Occupational therapists (OT) focus on a client's meaningful occupations (AOTA, 2020); specifically, in the ultra-Orthodox Jewish community, mothers invest a significant amount of their time performing the occupation of parenting (Peles et al., 2018). OTs also connect clients' occupation to their values and culture (AOTA, 2020). Linking Jewish values with therapeutic intervention for this population is critical in making the intervention both relatable and effective (Krieger, 2010).

Strategy

A literature review was conducted to identify the challenges associated with parents performing developmental monitoring and the culture of the

ultra-Orthodox Jewish community. Informal discussions with mothers in the ultra-Orthodox Jewish community were also conducted. The decision to focus on 2-year-olds was made because this is an age when children achieve the milestones of pointing to objects in a book and developing a bedtime routine, which are consistent with the goal of developing a storybook. This is also an age when children are due for developmental screening and can be eligible for early intervention services (CDC, 2022).

Outcomes

Based on the findings, a multifaceted children's book was created. The story focuses on creating a bedtime routine, an important skill for a child to develop (AOTA, 2020). The book uses age-appropriate language, sentence structure and literary tools, such as rhythm and repetition, to make the book engaging, memorable, and motivating for children. For example, the "bedtime rule" has a rhythm and rhyme scheme and is repeated throughout the book (Figure 1). The book also synthesizes educational information with Jewish values. For instance, the main character, Shimmy, is portrayed as a Jewish shark by having a common Jewish name, wearing a yarmulka, and performing the Jewish ritual of reciting the Bedtime Shema. This makes the material culturally relatable and thus effective (Krieger, 2010).

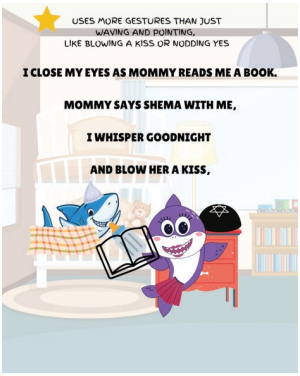
A secondary function of this book is to provide information on developmental milestones of 2-year-olds, as well as strategies for parents to help their children achieve those milestones. This narration is indicated by yellow stars, which are found at the top of several pages. The stars appear when the character performs specific milestones. For example, Shimmy the Shark blows his mother a goodnight kiss; a yellow star appears on the page, informing parents of this developmental milestone (Figure 2).

Figure 1

Bedtime Rule

Figure 2

Goodnight Kiss



Conclusions and Recommendations

A multifaceted children's book was created, using a client-centered and holistic approach, to educate ultra-Orthodox Jewish parents about the CDC developmental milestones, while promoting the co-occupation of parenting. This culturally sensitive tool can help mothers properly monitor their children and act early, thereby preventing further delays. It also helps children learn an age-appropriate, occupation-based bedtime routine.

The goal is to have the book published and available in Jewish bookstores and pediatricians' offices in Jewish communities. This book can also serve as a model for how to create culturally sensitive and relevant educational materials, and similar books could be created for different communities, age groups and their respective milestones.

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Paternal Reflective Functioning and its Impact on Joint Play

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Introduction

Fathers play a significant role in their child's development (Benbassat & Priel, 2015), and in Western societies, fathers are more involved with childcare responsibilities (Schoppe-Sullivan et al., 2021). Masculinity and gender-role beliefs may impact the relationship between father and child and their ability to participate in joint play (Benbassat & Priel, 2015). Father-son relationships and a father's manifestation of masculinity can specifically impact the son's aggressiveness, identity and social-emotional development (Casselman & Rosenbaum, 2014). Father-son relationships can also be impacted by parental reflective functioning (RF), which is the ability for a parent to understand their own feelings, desires, beliefs and the reasons they do what they do in themselves and others (Borelli et al., 2016). Fathers' RF is unique in that it has a role as a socializing agent (Benbassat & Priel, 2014), but its relation to perceived masculinity and how it impacts play between father and son is understudied.

This study aims to fill this gap in the literature by examining the relationship between fathers' RF, endorsement of traditional masculine ideology, and participation in joint play. The following hypotheses were set forth:

- The higher the father's RF, the more supportive the father is with his son in play.
- The higher the father's endorsement of traditional masculine ideology, the lower his RF.

Method

This project was part of a larger study under principal investigator Amber Cope, M.A., supervised by Sara C. Haden, Ph.D., and Amiya Waldman-Levi, Ph.D. Long Island University institutional review board (IRB) approved this observational study.

20 father-son pairs were recruited for this observational study. The study included heterosexual fathers over 18 and their typically developing sons between 4–8 years old who demonstrated understanding of written and spoken English. Fathers completed a set of self-report questionnaires: Male Role Norms Inventory-Revised (MRNI-R; Levant et al., 2007), which measures an individual's endorsement of traditional masculine ideology; Rumination-Reflection Questionnaire (Trapnell & Campbell, 1999), which measures parents' ability to reflect on their parental practices and thoughts toward their child and child's actions. Father-child's play in the home environment was video-recorded via Zoom and assessed using the Parent Support of Child Playfulness (PC-SCP) (Waldman-Levi & Bundy, 2016) assessment tool used to measure parent support of the playful behavior of the child.

Data was entered into SPSS (Statistical Program for the Social Sciences) Version 28. Descriptive statistics displayed sample characteristics and internal consistency was confirmed. Correlations between variables used Spearman's r, p was set to <0.05. A subsample (20% of the total sample) of videos were coded by a second, trained researcher to ensure inter-rater reliability of at least 80%.

Results

The sample consisted of 20 typically developing children and their fathers who were predominantly Caucasian, married and with an average age of 40.4 years, SD= 5.4. Children's average age was 5.9, SD= 1.9.

The first hypothesis was rejected; there was no significant correlation between the father's RF and the support provided to the child during joint play. The second hypothesis was accepted, the higher the father's RF, the lower was his masculine view of himself and vice versa (Table 1).

Table 1.
Associations between Father Support of Child Playfulness, Child's Playfulness, Father's Reflective Functioning, and Father's view on male role norms

	1	2	3	4
1. MRNI	-	.09	-.51*	-.10
2. PCSCP	.09	-	-.12	.18
3. Reflection	-.51*	-.12	-	.31
4. Rumination	-.10	.17	.31	-

Note. N=19-20; PCSCP- Parent/Caregiver Support of Child's Playfulness; MRNI- Male Role Norms Inventory; *p<.05

Conclusions and Recommendations

Identifying paternal behaviors and views can help occupational therapists develop interventions that foster children's development, social skills, and future relationships. A well-developed plan of care that adheres to the family dynamic can also improve communication skills within the family. This study presents a subset of a larger study; the current study subsample is small and recruited via convenience sampling method and can be recreated with a larger, more diverse sample.

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Providing Classroom Staff with Evidence-Based Resources to Support Independence in Students with Physical Disabilities

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Introduction

Cerebral palsy (CP) is a neuromuscular condition that may result in impaired movement associated with exaggerated reflexes, floppiness or spasticity of the limbs and trunk, unusual posture, involuntary movements and unsteady walking (Mayo Foundation, 2022). These characteristics make it difficult for children with CP to function independently throughout the school day, leading to high dependency on classroom staff.

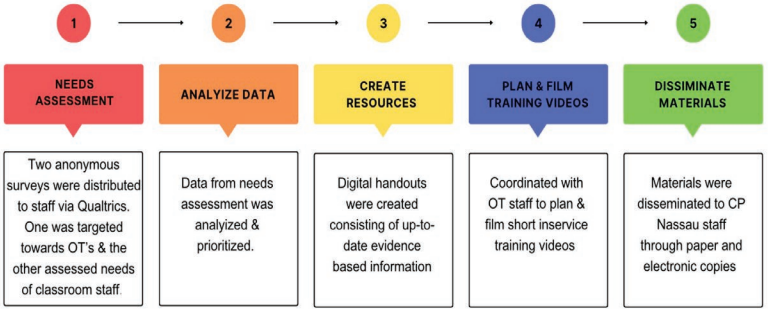
Students at CP Association of Nassau County (CP Nassau), a school catering to individuals with physical disabilities, require mobility and adaptive equipment, sensory equipment and custom hand splints. Classroom staff need to be well-versed in using this complex equipment. Research has shown that poorly trained classroom staff working with physically disabled individuals can negatively affect students, and it is crucial for classroom staff to receive consistent training to remain efficient at the point of need (Brannen et al., 2017). Video modeling in particular can be an effective training method for staff working with this population, with long-term positive effects on children's performance (Collins et al., 2009). Conducted in collaboration with the Occupational Therapy (OT) Department at CP Nassau, this project aimed at identifying classroom staff needs and developing resources to aid them in supporting their students throughout the school day.

Strategy

Two anonymous surveys were developed and distributed to CP Nassau staff. One survey targeted occupational therapists (OT), since they would be the ones distributing the resources, and the other survey was distributed to the classroom staff, assessing their confidence levels with varying equipment and learning styles. Figure 1 illustrates the project's procedures.

Figure 1

Procedures



Outcomes

Based on the survey results, fifteen digital/printable handouts were created with scannable QR codes that link to brief in-service training videos on the correlating topic (Figure 2). The materials were created in collaboration with the CP Nassau OT department and all information is up-to-date and evidence based. The materials were disseminated to OT staff at CP Nassau through paper and electronic copies.

Figure 2

Sample Handout

Conclusions and Recommendations

Occupational therapists and classroom staff who work with physically disabled students can benefit from training on the use of adaptive equipment in the classroom. This project employed readily available technology, like scannable QR codes and videos, which allowed staff members continuous access to specific in-service training materials for the proper use of the equipment their students rely on. This may lead to better outcomes for students by promoting students' maximal independence in daily tasks. OT practitioners play a critical role in supporting classroom staff in meeting the needs of students with physical disabilities. This training offers an easily accessible model that OTs can adapt to fill similar gaps in knowledge among teachers and other staff.

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Addressing Emotional Regulation through Interoception for Clinicians and Parents

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Occupational Therapy Doctorate

Introduction

Interoception, understanding one's internal bodily sensations, is the basis for forming emotional regulation (ER) during early childhood and throughout the lifespan. Interoception is first detecting an internal sense, then attending to internal sensations (Schauder et al., 2015). Biologically, research has identified the functional role of the anterior insula, part of the cerebral cortex which regulates the introduction of feelings into cognitive and motivational processes, in establishing a direct connection between bodily awareness and emotion (Zaki et al., 2012).

Emotional regulation (ER) results from interoception—from the processing in the brain to how the internal sensation was addressed. Therefore, discerning and attending to a child's needs or internal sensations, such as hunger, prove beneficial when addressing ER barriers to a child's occupational performance (Kingsley et al., 2020). A child will present with fewer unfavorable behaviors when their internal sensations are satisfied. Schaan et al. (2019) found that children who can count their heartbeats accurately before and after exercise present with increased interoception accuracy (IA) and are likely to present with improved ER, measured by the children's ability to respond to ER-related vignettes appropriately.

This project aimed to support parents and occupational therapists (OT) at My Kids Therapy, an OT sensory gym for children, through the development of:

- An evidence-based IA screening tool for children ages 4–6.
- An interoception treatment plan for OTs to treat children with IA and ER difficulties.

- An interoception resource for parents to support their children's IA and ER.

Strategy

This was a service for occupational therapists at My Kids Therapy as well as for parents and guardians of the clients obtaining treatment at the facility.

A survey was created to identify the needs of the largest population (4- to 6-year-olds) at My Kids Therapy, asking parents and OTs to indicate needs related to sensory integration (SI), play and ER. Survey results were evaluated to identify the greatest needs among OTs and parents. In addition, the director of the facility identified clients that would benefit from ER interventions. The survey results and proposed focus on interoception were presented to the director of My Kids Therapy for approval.

Relevant studies on IA and ER were gathered and evaluated, including the Jumping Jack Paradigm, an exercise for children ages 4–6 that quantifies changes in heart rate (HR) and its effect on ER (Schaan et al., 2019). This research informed the development of relevant resources for both OTs and parents.

Outcomes

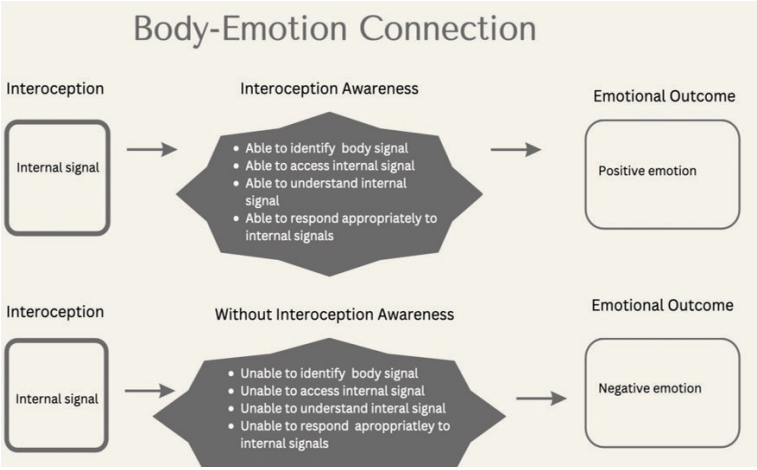
Parents of children (N=69) completed the survey. Their responses indicated a need for support in both SI and ER. The focus on interoception, which has implications for both SI and ER, was selected to meet this need. OTs also verbally requested a resource to address interoception.

An IA screening tool for OTs was developed. The tool uses the Jumping Jack Paradigm, which focuses on children's ability to count their own heartbeat. The screening tool is accessible via QR code. In addition, a voiceover PowerPoint containing general information about interoception and ER was developed for parents and caregivers to use in the home, also accessible via QR code.

A body-emotion connection diagram was developed to visually demonstrate the effect of interoception awareness on ER for clinicians, parents and families (Figure 1).

Figure 1

Body-Emotion Connection



Conclusions and Recommendations

Developing children's interoception is an important way to build emotional regulation. OTs at My Kids Therapy found the screening tool and resources developed to be useful and distributed it to families to support children's emotional regulation formation.

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Investigating Brain Injury in Domestic Violence Survivors and Individuals with Substance Misuse

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Introduction

Traumatic brain injury (TBI) is the modification in brain function, or other evidence of brain pathology caused by an outside force (Haag et al., 2019). TBIs are associated with lifelong physical, cognitive and psychological impairments, which can increase levels of mental illness (Campbell et al., 2018). Individuals with TBIs may become homeless, unemployed and impoverished, as TBIs may make it difficult to maintain a job (Haag et al., 2019). Early identification and intervention are critical in preventing lifelong complications from TBIs (Setnik & Bazarian, 2007). However, TBIs are underrepresented and unreported within marginalized populations, including those experiencing domestic violence (DV) and substance misuse. (Campbell et al., 2018; McCombie & Stirling, 2017).

Expanded understanding of the various patient populations who experience TBIs, such as DV survivors and individuals with substance misuse, is critical for the population-based effort in decreasing TBI-related disability (Setnik & Bazarian, 2007). This project aimed to increase awareness of TBIs in DV survivors and individuals with substance misuse disorder through the development and distribution of educational resources to relevant treatment and service agencies in the Virginia area.

Strategy

The domestic violence portion of this project focused first on outreach, including identifying and contacting DV agencies in the Virginia area to establish potential partnerships and resource sharing. This was followed by resource development, which entailed reviewing and expanding the Brain

Injury Association of Virginia's (BIAV) research base on TBIs and DV and developing evidence-based educational materials to be distributed to DV organizations.

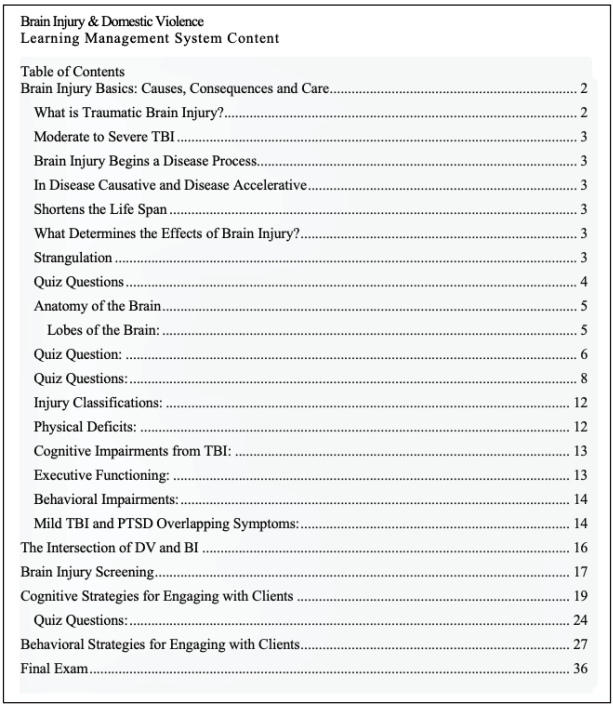
The substance misuse component of this project focused first on outreach, which entailed identifying and contacting opioid withdrawal treatment centers in the Virginia area for potential partnership and resource sharing. An online survey was then developed, to be administered by the centers to assess staff knowledge on TBIs and substance misuse. The survey included a combination of multiple choice and open-ended questions and Likert scale rating. Finally, an educational handout was created for treatment center staff on the relationship between TBIs and substance misuse.

Outcomes

Of the 20 of DV agencies contacted, none responded with interest in creating new partnerships or receiving educational materials. Some respondents indicated that staffing shortages limited the ability to partner. Educational resources were developed, including an outline (Figure 1) and corresponding materials that will be used by BIAV to create an online course to train DV agency staff in screening for TBIs and modifying treatment plans accordingly.

Figure 1

Table of Contents for DV and TBI Online Course



Brain Injury & Domestic Violence
Learning Management System Content

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Of the 30 opioid withdrawal centers contacted, a total of 3 completed the online survey. Respondents demonstrated minimal knowledge of the relationship between substance misuse and TBI. A fact sheet was created, providing information on substance misuse and TBIs, with the goal of early intervention. The handout addressed signs, prevalence, and treatment options for TBIs.

Conclusions and Recommendations

This project aimed to increase awareness of the relationship between DV, substance abuse and TBIs. The educational materials created can help staff in DV and substance misuse agencies better recognize TBIs amongst their clients, improving treatment strategies and overall client care. These materials may also benefit occupational therapists, who have the clinical training required to accurately screen for TBIs and cognitive impairments.

The low response rates for both DV and substance misuse facilities indicates that additional strategies should be employed to better access sites and meet their needs. These strategies may include expanding the study area; offering free in-service Zoom calls as a benefit for survey takers; and providing an incentive, such as a gift card, for taking the survey.

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Occupational Therapy Fieldwork Educator Training

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Introduction

Fieldwork educators are critical for the occupational therapy profession's growth and continuity. However, there appears to be a deficit in the number of occupational therapists (OT) taking on supervisory roles in Fieldwork Level II placements (Varland et al., 2017). OTs would be more inclined to supervise fieldwork students if they had access to resources to support them in the transition from healthcare practitioner to educator (Evenson et al., 2015). Therefore, there is a need to establish more structured educational experiences for OTs who are interested in taking on the role of a fieldwork educator.

The aim of this project was to create a succinct, evidence-based and cost-free fieldwork educator course for current fieldwork educators or potential fieldwork educators to give them the tools they need to feel confident and prepared to be competent fieldwork educators. This project was completed in conjunction with Dr. Patty Laverdure at the Virginia Occupational Therapy Educational Council (VAOTEC).

Strategy

The first step to creating this educational resource was to conduct a scoping review of the literature to identify the specific information clinicians are lacking, the skills and training necessary to support them in becoming fieldwork educators, and the key characteristics of effective clinical educators. Because the current literature does not identify what content would be most effective in training new OT fieldwork educators, this resource was developed based on research from related healthcare disciplines. The next step was distillation of the literature, followed by educational content selection

and development, including selection of material from VAOTEC's existing fieldwork educator resources. Following that, educational modules were organized and published.

Outcomes

The reviewed literature showed that the most important characteristics for clinical educators include strong communication skills and the ability to provide constructive feedback (Gibson et al., 2018; Koski et al., 2013). Effective fieldwork educators also display strong teaching skills, interpersonal awareness, approachability and the ability to create a positive learning environment (Collier, 2013; Grenier, 2015; Koski et al., 2013). Using research articles on these characteristics as a base, training modules were created to develop each of these skills in prospective fieldwork educators. Each training module included a voice-over PowerPoint presentation, PowerPoint slides, review quizzes and additional resources.

The resulting fieldwork educator training course is currently available as a step-by-step module on Canvas. OTs can log on and access all content with any email address. VAOTEC will transition the modules so that they are directly available on the VAOTEC website.

Conclusions and Recommendations

The OT fieldwork educator training modules will enhance OT practice by providing the knowledge and direction necessary for OTs to transition into effective fieldwork educators. A systematic review exploring characteristics of effective OT clinical educators is in process, with a data collection spreadsheet in place. Conducting this systematic review will provide Level 1 evidence, allowing fieldwork educators to gain an understanding of best practices for clinical education in OT and helping to advance this knowledge across the healthcare community.

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Does Increased Cell Phone and Tablet Use by Parents and Caregivers Impact the Social Language Skills of Developing Children?

Molly Hampton
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Introduction

Language learning is the product of the interaction of the child's learning capacities with the environment (Feldman, 2019). For a child to learn language, a parent or caregiver should enrich their environment with various language samples. As an infant begins to develop life skills such as communicating wants and needs to caregivers, there are many factors that play into their rate of development. This study aimed to explore whether an increase in technology use—primarily cell phone and tablet use—by parents and caregivers impacts the social and language developmental milestones of developing infants.

Strategy

A systematic search and review of literature was conducted to examine the effect that technology use has on children's speech and language development. Literature included in this review was retrieved from one electronic database, PubMed, and an initial search yielded over 200 results. Research papers were limited to those that are written in English and published or included in databases from 2016 to February 2022. Abstract and overviews were scanned to determine relevancy. This yielded 23 results, which were narrowed down to six final articles for detailed analysis.

Findings

A detailed analysis of six research studies revealed that human interactions are necessary for early language learners to accurately develop and attain language skills. Within human interactions, warm, low-stress exchanges between infants and adults are required to facilitate language learning; screens do not compare to human-to-human exchanges (Feldman, 2019). At 12 months old, reported as the median age for screen exposure, children are just beginning to develop and hone their social-emotional skills. Many developmental milestones at 12 months rely heavily on aspects such as eye-contact and social interaction (Kılıç et al., 2018). In support, the CDC (2022) reports that "screen time is not recommended for children under 2 years of age." A study by Li et al. (2022) found that parental screen use can have various effects on children outside of speech but directly related to speech development. For example, if a child's anxiety is increasing, this has the potential to negatively affect the child's self-confidence, which can negatively impact the child's speech abilities.

Conclusions and Recommendations

It is important for speech-language pathologists and other health professionals to be cognizant of the impact that exposure to technology has on language acquisition to accurately assess a child for a possible communication or developmental delay or disorder. Identifying and treating communication disorders or delays early on is a highly beneficial way to set a child up for communication success later in life. It is evident that more in-depth research is needed to fully understand the effect that technology has on children's development.

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Comparing Performance of Bilingual and Monolingual Students in Math and Science Assessments

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Introduction

Within the public school system, many students have diverse cultural, ethnic and racial backgrounds (Baecher et al., 2012). These students may be exposed to one language at school, home or place of worship (monolingual) or to two or more languages (bilingual/multilingual). Research has shown that being exposed to multiple languages enlarges a student's vocabulary, which ultimately impacts a student's academic performance positively (Mindt et al., 2008). This literature review aimed to compare the performance of bilingual (English-Spanish) students with their monolingual peers on classroom assessments in mathematics and science to understand whether bilingualism provides an advantage in cognitive and language development.

Strategy

A search was conducted using Google Scholar, limited to articles that contain specified age groups, populations, and academic courses. There were no restrictions on study designs. The quality of evidence was evaluated by selecting peer-reviewed, evidence-based articles, measuring their relevance, and signifying why they were directly relevant to the study question. In the analysis of the papers found, participants were split into two groups: English-Spanish bilingual students and monolingual students.

Math and science assessments were specifically selected to evaluate how students process and comprehend information. The specialized vocabulary required to comprehend scientific and mathematical concepts eliminates the possibility of monolingual students using their prior English-based lexicon as an advantage, creating a more level playing field and baseline for comparison.

Outcomes

The initial database search resulted in over 200 articles. These were narrowed down by excluding certain age groups and populations, as well as articles that did not include key criteria of "English-Spanish bilingual" and "math or science assessment." After additional screening of the remaining titles/abstracts, five peer-reviewed studies were selected for detailed analysis.

The reviewed studies indicate that bilingual English-Spanish speaking students performed the same and, in some cases, better than monolingual students on science assessments (Bravo & Cervetti, 2014). August et al. (2009) found that English-Spanish bilinguals gained vocabulary knowledge on science assessments similar to their monolingual peers due to visual models and accommodations.

Research also shows that bilingual students are at an advantage with regards to cognitive function. According to Bialystock (2011), bilingual students had faster reactions than monolingual peers during nonverbal activities, indicating strong cognitive skills. Secada (1991) also concluded that bilingual learners are capable of challenging tasks such as problem-solving, just as monolingual students are, due to their advanced cognitive development.

Conclusions and Recommendations

Bilingual students performed better on science assessments, but further research must be conducted to determine bilingual students' performance on math assessments. Research does show, however, that due to their high levels of cognitive function, bilingual students succeeded in problem-solving.

This research can help speech-language pathologists (SLP) better understand bilingual students' thought processes, which can be applied to the academic environment with their case load. SLPs, educators and interprofessional collaborators who work with bilingual children may be able to leverage bilingual students' cognitive strengths when developing educational and therapeutic interventions, visual supports and prompts. As more diverse students enter the school systems, these findings indicate a need for more research to support the growing population of diverse, multilingual learners.

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Identifying the Gap: Clients Denied/Delayed Early-Intervention Speech and Language Services Due to New CDC Milestones

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Introduction

In February 2022, the Centers for Disease Control (CDC) changed the developmental milestones, which refer to things most children can do at a certain age, such as taking a first step or waving goodbye. When a child shows a delay in meeting a certain developmental milestone, they may qualify for relevant early-intervention services, including speech and language therapy.

The CDC's modification of developmental milestones included delaying selected speech and language milestones by six months. The impetus for this change was determined by an extensive review of literature and developmental scales done by a group of subject matter experts chosen by the American Academy of Pediatrics, none of whom were speech-language pathologists, and normative data for individual milestones remains sparse (Sheldrick et al., 2019).

The decision to delay milestones yields a range of ramifications for young children and their families (Whetherby et al., 2021). Communication and language delays are often the first developmental delays identified and, if not addressed in a timely manner, can negatively impact a child's learning, communicative, behavioral, social and reading abilities as well as access to key early-intervention services. The aim of this study was two-fold:

- to determine the percentage of children whose qualification for early-intervention speech and language services will be delayed or denied because of the new CDC guidelines.

- to determine the length of time that children would be delayed receiving early-intervention speech and language services for the purpose of identifying contributing risk factors for communication disorders and overall development.

Method

Sixty-three speech-language pathologists who met the following inclusionary criteria voluntarily participated in the study: 1. Participants must have had an early-intervention caseload before February 2022; 2. Participants must be able to consider an early-intervention client who was just missing or meeting their speech and language developmental milestones; and 3. English must be the primary language of the client considered.

A survey was designed that presented both sets of developmental milestones published by the CDC (the "previous milestones" and the "new milestones"). Participants were asked to consider the specific early-intervention case described above and to check off the milestones that the child had met according to both sets of milestones. Participants then compared the child's performance in both sets of milestones to determine if children were being delayed or denied qualification for early-intervention speech services and by how many months.

Additionally, participants were asked how many parents of clients they worked with were aware of the change in developmental milestones, and how the changes in developmental milestones have affected or will affect the delivery of therapy for early-intervention clients.

Results

Of the sixty-three surveys completed, 49% reported their clients qualified for services later than they would have due to the change in developmental milestones (Figure 1). Of the 49% who qualified later, 55% qualified three months later than they would have, and 45% qualified six or more months later than they would have under the previous milestones (Figure 2).

Figure 1

Percentage of Children Affected by Milestone Changes

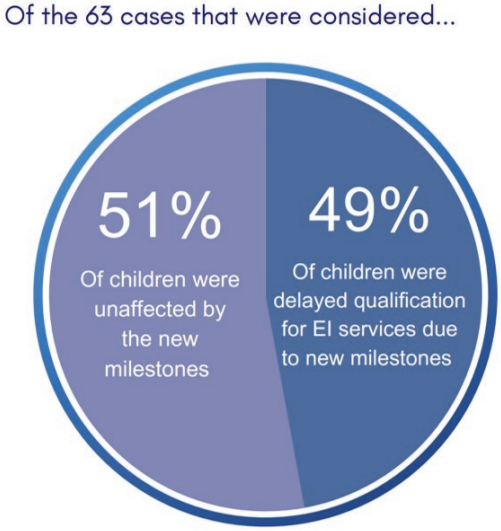
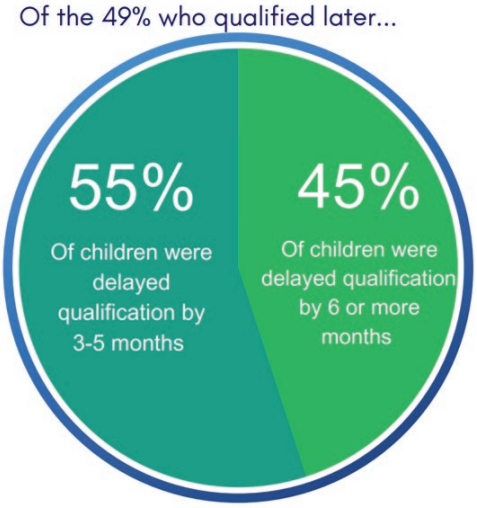


Figure 2

Percentage of Children Delayed Qualification by Months



According to early-intervention SLPs, on average only 24% of parents of early intervention clients were aware of the change to developmental milestones. Less than 1% (4 out of 63) clients aged out of qualification for services due to the change in milestones. The biggest delay in qualification for services occurred in the 9- to 12-month range. However, with the addition of the 15-month and 30-month milestone markers, 30% of clients qualified earlier than they would have in the past.

Conclusion and Recommendations

This study revealed that the change in developmental milestones resulted in both positive and negative outcomes for clients ages 0-3 years old. The addition of the 15- and 30-month milestones led to earlier intervention qualification for 30% of clients considered. This yields a positive outcome, by allowing older clients to be identified sooner, aligning with the "act early" approach supported by the CDC. However, 49% of the clients considered qualified for early intervention services significantly later than they would have under the "previous milestones," potentially leading to further speech and language delays. It is recommended by the researcher that the CDC return to the "previous milestones," with the addition of the new 15- and 30-month milestone markers.

With only 24% of parents aware of the recent changes to the developmental milestones, increasing awareness of these changes is critical so parents, providers and early childhood educators can be informed and aware of the impact of this pertinent information. In future research, increasing the sample size of speech-language pathologists surveyed would yield more data, better identifying the percentage of children who qualify for services under the new milestones, as well as increasing the impact and validity of the study.

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Notes

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