Using Functional Communication Skills to Predict Verbal Intelligence in Pediatric Patients with Cisplatin-Induced Hearing Loss

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Introduction

Ototoxicity - damage to the ear as a side effect of a medication or drug

CISPLATIN → 

(WordPress, 2014)

Severe hearing loss in 47% of children treated with <400 mg/m^2 of cisplatin (Landier *et al.*, 2014)

Likelihood increases in certain patient subsets:

- Younger age
- Exposure to other chemotherapy drugs
- Higher doses of cisplatin
- Cranial irradiation

- 2022: Sodium thiosulfate approved as an otoprotectant by the FDA
- Found to be 50% effective (Freyer *et al.*, 2017)
- Not approved for all patients

Review of Literature

Olivier *et al.* (2019)

Pediatric survivors of embryonal brain tumors with **severe hearing loss**:

- Significantly lower scores for phonemic skills, phonetic decoding, reading comprehension, and speed of information processing ($P \leq .05$)
- Scores in these areas had a sharper decline over time

Lima *et al.* (2023)

Children with hearing aids/cochlear implants had significantly lower scores in many neurocognitive domains compared to their normal hearing peers

- **Functional communication** - effectively communicate feelings and basic needs
- **Verbal intelligence** - understand and analyze concepts using written and/or spoken words

Gap in the Knowledge

- Studies examining neurocognitive impacts of hearing loss do not often focus on ototoxicity/cisplatin-induced hearing loss
- A relationship between **functional communication** and **verbal intelligence** has not yet been determined

Purpose

To determine if a **predictive relationship** exists between functional communication and verbal intelligence in pediatric patients with cisplatin-induced hearing loss

- Improve quality of life for childhood cancer survivors
- Better understand how ototoxicity impacts brain function

Hypothesis

Functional communication scores can be used to predict **verbal intelligence** test results in pediatric cancer patients with **cisplatin-induced hearing loss**

→ Greater deficiencies in functional communication will correspond with greater deficiencies in verbal intelligence

Methodology

PARTICIPANTS

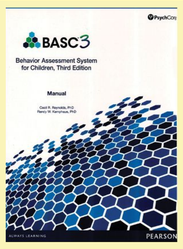
Received IRB approval and patient consent

83 → **24**

Prescribed hearing aid and/or Grade 2+ with International Society of Pediatric Oncology (SIOP) Boston Ototoxicity Scale

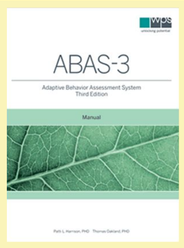
NEUROCOGNITIVE MEASURES

Functional Communication



(Pearson Assessments, 2015)

OR



(Pearson Assessments, 2015)

Crystalized Verbal Intelligence

WISC®-V

(Pearson Assessments, 2014)

VARIABLES

Independent	Dependent
Functional communication (FC) t-score	Crystalized verbal intelligence (CVI) t-score

Controlled

1. <18 years at neuropsych evaluation
2. Cancer survivor
3. Received cisplatin
4. Diagnosed with hearing loss
5. Received care through the same hospital

Results

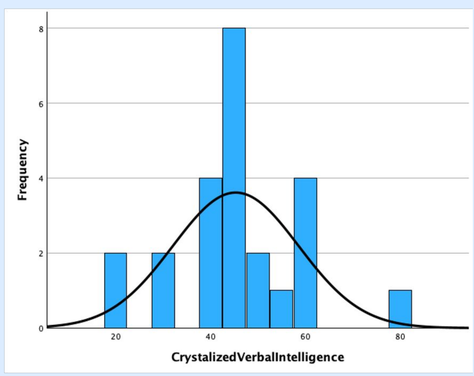


Figure 1: Histogram of crystalized verbal intelligence scores with a normal distribution **(Kolmogorov-Smirnov = .150)**

Correlations

		Communication Combined Measured	Median Income by Zip	Cumulative amount of cisplatin (mg/m2)	Total amount of radiation to brain (centigrays)	Age at Dx (months)
Communication Combined Measured	Pearson Correlation	1	.179	.121	−.149	.105
	Sig. (2-tailed)		.402	.574	.488	.626
	N	24	24	24	24	24
Median Income by Zip	Pearson Correlation	.179	1	.027	.174	−.116
	Sig. (2-tailed)	.402		.902	.416	.591
	N	24	24	24	24	24
Cumulative amount of cisplatin (mg/m2)	Pearson Correlation	.121	.027	1	−.164	.121
	Sig. (2-tailed)	.574	.902		.443	.573
	N	24	24	24	24	24
Total amount of radiation to brain (centigrays)	Pearson Correlation	−.149	.174	−.164	1	.094
	Sig. (2-tailed)	.488	.416	.443		.663
	N	24	24	24	24	24
Age at Dx (months)	Pearson Correlation	.105	−.116	.121	.094	1
	Sig. (2-tailed)	.626	.591	.573	.663	
	N	24	24	24	24	24

Figure 2: Correlation matrix showing weak correlation between all independent variables **(Low Pearson Correlation)**

Model Summary[c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics: R Square Change	F Change	df1	df2	Sig. F Change
1	.714[a]	.510	.407	10.197	.510	4.952	4	19	.007
2	.743[b]	.552	.427	10.024	.041	1.661	1	18	.214

a. Predictors: (Constant), Median Income by Zip, Cumulative amount of cisplatin (mg/m2), Age at Dx (months), Total amount of radiation to brain (centigrays)

b. Predictors: (Constant), Median Income by Zip, Cumulative amount of cisplatin (mg/m2), Age at Dx (months), Total amount of radiation to brain (centigrays), Communication Combined Measured

c. Dependent Variable: Crystalized Verbal Intelligence

Coefficients[a]

Model		Unstandardized Coefficients: B	Unstandardized Coefficients: Std. Error	Standardized Coefficients: Beta	t	Sig.	Correlations: Zero-order	Correlations: Partial	Correlations: Part	Collinearity Statistics: Tolerance	Collinearity Statistics: VIF
1	(Constant)	12.413	11.855		1.047	.308					
	Total amount of radiation to brain (centigrays)	−4.874E−5	.001	−.010	−.060	.953	.134	−.014	−.010	.922	1.084
	Cumulative amount of cisplatin (mg/m2)	−.001	.024	−.004	−.027	.979	.042	−.006	−.004	.948	1.054
	Age at Dx (months)	.061	.047	.211	1.282	.215	.127	.282	.206	.952	1.051
	Median Income by Zip	.000	.000	.710	4.301	<.001	.683	.702	.690	.947	1.057
2	(Constant)	4.446	13.192		.337	.740					
	Total amount of radiation to brain (centigrays)	.000	.001	.031	.183	.857	.134	.043	.029	.890	1.124
	Cumulative amount of cisplatin (mg/m2)	−.003	.024	−.019	−.114	.910	.042	−.027	−.018	.944	1.059
	Age at Dx (months)	.052	.047	.181	1.107	.283	.127	.252	.175	.932	1.072
	Median Income by Zip	.000	.000	.661	3.971	<.001	.683	.683	.627	.898	1.113
	Communication Combined Measured	.239	.186	.213	1.289	.214	.344	.291	.203	.908	1.101

a. Dependent Variable: Crystalized Verbal Intelligence

Figure 3: Model summary from hierarchical multiple regression showing variance in the model

Figure 4: Coefficient table from hierarchical multiple regression with median income as the only significant variable

Discussion

Histogram of CVI

- Non-significant Kolmogorov-Smirnov value indicates **normal distribution**
- Data can be tested for a linear relationship

HIERARCHICAL MULTIPLE REGRESSION

Control for: Median income by zip code, Total amount of cisplatin (mg/m^2), Amount of radiation to the brain (cGy), Age at cancer diagnosis (months)

Correlation Matrix

- Weak correlation between independent variables (low Pearson Correlation values)
- Hierarchical multiple regression is **reliable**

Model Summary

- **FC** explained 4.1% of variance
- Statistically insignificant contribution ($p = .214$)

Coefficient Table

Functional communication has a significance level >.05 ($p = .214$)

↓

Unable to show a predictive relationship between **FC and CVI**

Only median income by zip code was significant ($p < .001$)

↓

Significant relationship between **socioeconomic status and CVI**

Limitations

Narrow specifications for hearing loss and neuropsychological data

Small sample size (24 participants)

Decrease accuracy of results

Future Research

- Reexamine the study with larger sample size
- Look at the effect of cisplatin ototoxicity on different neuropsych domains
- Study the relationship between socioeconomic status and ototoxicity

Conclusion

Highlighted the role of **socioeconomic status** on children's verbal intelligence

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(Carter, 1918)

Improve **quality of life** for patients

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More treatments / better economic equality

Inspire future research in the fields of neurocognition and ototoxicity