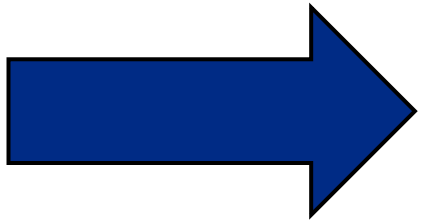
Using Functional Communication Skills to Predict Verbal Intelligence in Pediatric Patients with Cisplatin-Induced Hearing Loss

Julianna Blackman

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

CISPLATIN



(WordPress, 2014)

47% of children treated with <400 mg/m^2 of cisplatin had severe hearing loss

(Landier *et al*., 2014)

Likelihood increases in certain patient subsets:

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

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

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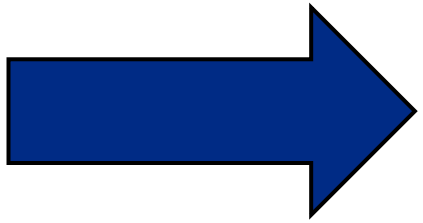


(WordPress, 2014)

FDA approved sodium thiosulfate as an otoprotective treatment for cisplatin in 2022

Found to be 50% effective (Freyer *et al*., 2016)

Not approved for all patients who are susceptible to ototoxicity from cisplatin

NEUROCOGNITION

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

(Olivier *et al*., 2019)

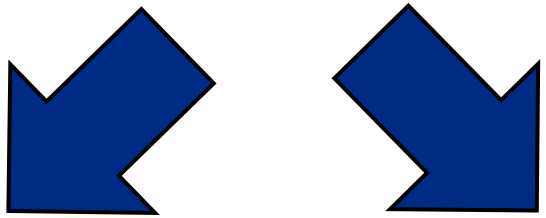
Children with hearing aids or cochlear implants had significantly lower scores in many neurocognitive domains when compared with their normal hearing peers (Lima *et al*., 2023)

GAP IN THE KNOWLEDGE

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

PURPOSE

To determine if there is a **predictive relationship** between functional communication skills and verbal intelligence in pediatric cancer survivors with cisplatin-induced hearing loss



Improve patients' quality of life

Better understand how ototoxicity impacts brain function

HYPOTHESIS

Functional communication scores can effectively 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

PARTICIPANTS

Received IRB approval and patient consent

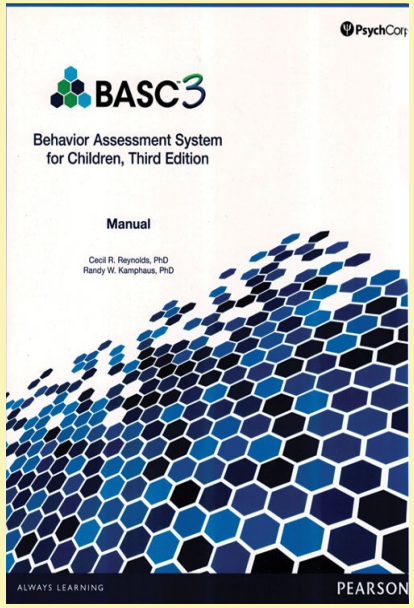
83 → 24

Prescribed hearing aid and/or SIOP Boston Ototoxicity Scale (Grade 2+)

Missing data for neuropsychological tests

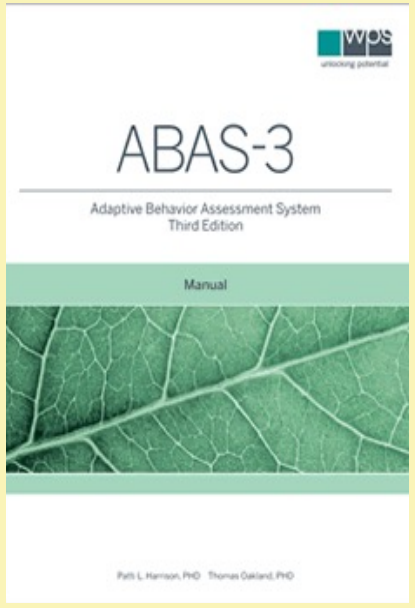
NEUROCOGNITIVE MEASURES

Functional Communication



(Pearson Assessments, 2015)

OR



(Pearson Assessments, 2015)

Crystalized Verbal Intelligence (CVI)

WISC®-V

(Pearson Assessments, 2014)

VARIABLES

INDEPENDENT

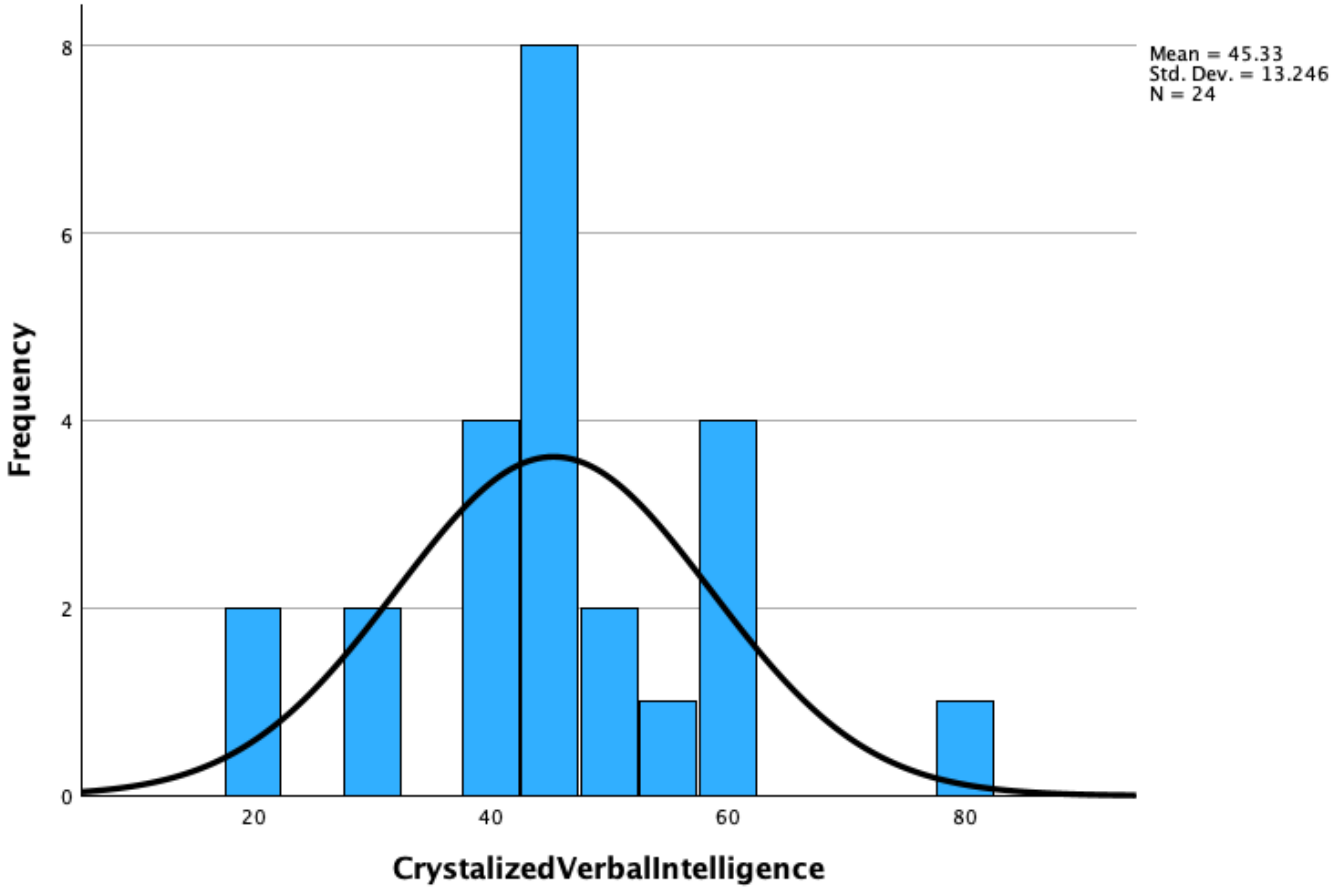
Functional communication t-score

DEPENDENT

Crystalized verbal intelligence t-score

CONTROLLED

1. <18 years at neuropsychological evaluation
2. Cancer survivor
3. Received cisplatin
4. Diagnosed with hearing loss post-treatment
5. Received oncological/follow-up care through the same pediatric hospital



HISTOGRAM OF CVI SCORES

- Skewness = .321
  - Standard error = .472
- Kurtosis = 1.257
  - Standard error = .918
- **Kolmogorov-Smirnov = .150**

Figure 1: Histogram of crystalized verbal intelligence scores with a normal distribution

Hierarchical multiple regression to control for:

1. Median income by zip code
2. Cumulative amount of cisplatin (mg/m^2)
3. Amount of radiation to the brain (centigrays)
4. Age at cancer diagnosis (months)

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

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

Figure 3: Model summary showing variance in the model

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	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

- Explains 4.1% variance

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

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a. Dependent Variable: Crystalized Verbal Intelligence

- Explains 4.1% variance
- Contribution was not significant

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a. Dependent Variable: Crystalized Verbal Intelligence

- Explains 4.1% variance
- Contribution was not significant
- Only SES was significant (<.001)

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

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a. Dependent Variable: Crystalized Verbal Intelligence

- Explains 4.1% variance
- Contribution was not significant
- Only SES was significant (<.001)
- Functional communication: higher sig. level of .214

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- Unable to show a predictive relationship between functional communication and CVI
- Significant relationship between median income and CVI

Pediatric brain tumor survivors who received radiation therapy:

Lower SES = lower neurocognitive scores

(Torres *et al*., 2021)

Hearing loss increases chances of unemployment, low educational attainment, low income

Lower SES = less likely to receive hearing care or wear hearing aids

(Malcolm *et al*., 2023)

LIMITATIONS

- Small sample size (24 participants after starting with 83)
- Narrow specifications for hearing loss and neuropsychological data
- Decrease accuracy of results

FUTURE RESEARCH

- Reexamine the study with a larger sample size
- Other neuropsychological domains
- Relationship between SES and cisplatin-induced hearing loss

CONTRIBUTIONS TO FIELD OF STUDY

- Highlighted the role of SES on children's verbal intelligence
- Lead to more treatment options, better economic equality
- Inspire future research regarding neurocognition and ototoxicity

SOURCES

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