Using Big-Data to Drive Effective Clinical Decision Making in Aphasia

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* Kiran (2016). How does severity of aphasia influence individual responsiveness to rehabilitation: Using big-data to understand theories of aphasia rehabilitation, Seminars in Speech and Language, 37; 1-14

Disclosure

- Has significant financial interest
  - Scientific Advisor for Constant Therapy
  - Ownership stock in Constant Therapy

Achieve functional communication independence

Learning and experience results in plasticity

More intensive training increases plasticity

Cortical plasticity depends on undamaged tissue

Identify the optimal rehabilitation

Predict the degree of impairment

Predict the degree of improvement

How much therapy is enough?

Age

Lesion location

Lesion size/volume

Months post stroke

Education

Severity of impairment

Duration of treatment

Type of treatment

Neural Markers
Impairment based intervention
Which treatments work for which patients?
Predict the degree of improvement

○ Review studies of rehabilitation outcomes in individuals with chronic aphasia report that therapy is indeed effective for these individuals
  • Very early aphasia therapy in acute aphasia
  • Systematic review of constrained induced aphasia therapy
  • Systematic review of aphasia therapy studies

○ A recent influential study (ACTNOW) suggested that rehabilitation was no more effective in promoting change in the measured outcomes than everyday communication with hospital volunteers in acute stroke survivors
  • A best-practice, feasible intervention by NIH 3T3 therapists, up to three contacts per week for up to 16 weeks compared with a similar number of AC contacts by employed visits
  • There was no evidence, on any measure, of added benefit of early communication therapy beyond that from AC

○ Functional communication improved for both groups

A Cochrane review of randomized controlled trials in aphasia have been less favorable. Some promising evidence but not strong outcomes.

Kiran & Thompson, 2003

Question #1: What do you think about the effectiveness of aphasia rehabilitation

Always effective
Mostly effective but depends on intensity
May be effective with intense therapy
Not convinced its effective

Kiran & Thompson, 2003

Technology and big data changing rehabilitation
Using technology to improve treatment delivery

- Main advantage is to provide therapy to people who cannot travel to obtain rehabilitation services.
- Speech language pathology services are particularly suited to telerehabilitation due to the emphasis on auditory/visual interaction.
- Thus far, videoconferencing between client and clinician for audiology, swallowing, and motor speech have been reported (Georgiadis et al., 2004; Hill et al., 2003).
- Several centers set up for providing aphasia therapy over the Internet (City University, London; University of North Carolina, Greensboro).

Question #2: What are the advantages and disadvantages of technological applications in aphasia therapy

Advantages??

Disadvantages?
Current technological applications

- Virtual therapist
- Single function computer programs
- Multifunctional programs

Sentact i cs is a computer-automated program that trains patients in comprehension and production of complex sentences based on TUF.

"Sabrina," an automated clinician, presents the patient with stimuli and gives feedback about the patient's performance.

2010;24(10):1242-1266.

Cherney LR. Top Stroke Rehabil.

Computerized Brain Rehabilitation Software

- Multifunctional software
- Makes different types of cues (semantic, phonemic, general information) available to patients as they practice word retrieval. Results from patients with aphasia who received multifunctional therapy improved on the Boston Naming Test (BNT), but the changes were not significant when compared with the control group. A similar result was observed by the center for cardiac rehabilitation.

- Monofunction
- Also provides patient-initiated cues during word retrieval. This program was shown to be effective in increasing patients' comprehension and lessening word retrieval deficits in aphasic individuals and those who had semantic dementia.

Therapy Outcomes

- Age
- Lesion location
- Lesion size/volume
- Months post stroke
- Education
- Type of treatment
- Duration of treatment

Step-by-step:
- Pomer et al. found that computer-delivered treatment may improve the naming ability of patients with aphasia. Aphasia therapy was provided to a group of patients with chronic aphasia using computer-automated treatment. The results showed significant improvement in naming ability compared to the control group. A similar result was observed by the center for cardiac rehabilitation.

- Ungraphics
- Structured language therapy to 50 patients in community settings showed improvements on standardized tests such as the WAB and CST.

- Constant Therapy
- Standardized and individualized treatment for 51 patients using the software showed significant changes on WAB, CLOC, BNT etc.
Question #3: What do you think about the influence of severity of aphasia in outcomes

- The more severe, the poorer the outcomes
- The more severe, the better the outcomes
- Severity does not influence outcomes
- I don't know!

Study #1

- In a meta-analysis, Robey showed that acute patients with severe aphasia show substantial gains after treatment but chronic patients with moderate and severe aphasia also show substantial gains after rehabilitation.


- In chronic aphasia, Pond and colleagues reviewed outcomes from rehabilitation centers that provide intensive comprehensive aphasia treatment and found both mild and severe chronic patients with aphasia to benefit from such treatment.

Assess baseline performance

Assign individualized set of tasks

Patient performs tasks

Clinician remotely monitors progress and alters plan

Task assigned if accuracy less than 80% on first session

Des Roches et al., 2015, Frontiers in Human Neuroscience

Kiran et al., 2014, Seminars in Speech and Language, Kiran, 2014, IJPMR

Des Roches et al., 2015, Frontiers in Human Neuroscience

Patient profile view

Assign individualized set of tasks

Patient performs tasks

Experimental patients in clinic and home
Control patients in clinic only

Des Roches et al., 2015

Kiran et al., 2014, Seminars in Speech and Language, Kiran, 2014, IJPMR

Des Roches et al., 2015, Frontiers in Human Neuroscience
Weekly clinic sessions

- Keep the task or modify the task.
- If the participant achieved 95% or higher accuracy two times in succession.
- The clinician would either progress the next level of difficulty or different task.
- If a participant was not improving on a task over time, either a lower level of task was assigned or in replacement of the original task.
- A different task examining the same skill.
- No change.

Overall experimental participants show beneficial and significant change.

Participants with a lower than average WAB AQ score show more improvement in accuracy.

Participants with a higher than average CLDT score show more improvement in accuracy.

Light blue: participants with a lower score than average show more improvement in the task.

Dark blue: participants with a higher score than average show more improvement in the task.

Experimental patients show more significant changes on standardised tests than control patients.

Patients with lower initial scores showed more improvements than patients with higher initial scores.
The result is what I expected. Makes sense, more severe patients have to gain more, but do they need more therapy? I really don't think it's about severity. I don't know!

Des Roches et al., in preparation

Examined individual differences in the way patients used cues to solve the tasks.
- 51 individuals with aphasia,
- 10 week therapy program using the Constant Therapy software platform,
- Participants could self-administer hints (available in 28 of the 37 tasks).

Follow up- Study #2
- Examined individual differences in the way patients used cues to solve the tasks.
- 51 individuals with aphasia,
- 10 week therapy program using the Constant Therapy software platform,
- Participants could self-administer hints (available in 28 of the 37 tasks).

Hint use and accuracy
- Examined individual differences in the way patients used cues to solve the tasks.
- 51 individuals with aphasia,
- 10 week therapy program using the Constant Therapy software platform,
- Participants could self-administer hints (available in 28 of the 37 tasks).

What is the relationship between accuracy and hint use?
- First, a simple regression of the count of all hints self-administered within a session and average accuracy within the session for all participants
- Hint use had a significant relationship with accuracy.
- K-means cluster analysis for sample participants.
What is the relationship between accuracy and hint use?

Patients form five subgroups in terms of whether increased hint use is associated with increased accuracy.

Des Roches et al., in preparation

What is the relationship between accuracy and hint use?

Are participants’ severity profiles related to frequency of self-administered hint use?

- Pearson correlation of frequency of hint use with all standardized test scores and demographic information.
- All severity measures negatively correlated with frequency of hint use.
- The more severe the participant, the more frequently they used hints.

Des Roches et al., in preparation

Combining severity and frequency of hint use

Overall accuracy on task ranges between 75%-85%

These participants used hints infrequently and had the highest scores on most of the standardized measures.

Des Roches et al., in preparation

Combining severity and frequency of hint use

Low but beneficial hint use

Des Roches et al., in preparation

Combining severity and frequency of hint use

High but non-beneficial hint use

Des Roches et al., in preparation
Question #5: What do you think about the influence of self-administered cues on aphasia in outcomes

- Don’t use patients
- Check whether cues help before you allow cues
- Without cues, treatment can be very frustrating!
- I don’t know!

How can big data inform clinical decision making?

Methods & Analysis

- Patients download the app and sign up for an account.
- Based on an initial baseline assessment, a given task is assigned as long as its performance is between 40% and 90% accuracy and average latency.
- For the analysis, compared post (average of the last 10 items of the given task type and level) – pre (average of the first 10 items of the given task type and level).
- Drop the first three items of a given task.
- Paired t-test, two-tailed. Only consider p < .05 as statistically significant changes.
- Same analysis for accuracy and latency.

Less than 90% accuracy
Less than 80% accuracy

Less than 70% accuracy

Less than 60% accuracy

Less than 50% accuracy

Less than 40% accuracy

What does this tell us about severity?
What does this tell us about severity?

Severely impaired patients make strong gains in treatment.

Implications for providing therapy services for severely impaired patients.

Prognosis is good not just for mildly impaired patients.
Predict treatment outcomes before treatment even begins

Age
Lesion location
Lesion size/volume
Months post stroke
Education
Severity of impairment
Duration of treatment
Type of treatment

Therapy
Outcomes

Current effect: \(F(24, 938) = 5.7551, p = .00000\)

With more practice, greater than 500 items, improvements are between 30-50 points for more severe patients, slightly less for less severe patients.

With less practice, less than 40 items, improvements are between 10-30 points for more severe patients, even less for less severe patients.

Average gain in accuracy in points

More severe
Less severe

More practice
Less practice

Patient starting accuracy (severity)

-0.1
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
What does this tell us about severity?

The less severely impaired patients show minimal gains with less practice, but more severely impaired patients show some gains with less practice.

The less severely impaired patients show 10-20 point gains with more practice whereas the more severely impaired patients show 30-50 points gains.

More practice is needed for more severe patients to achieve gains.

To reach the same level of improvement (90%) more severe patients need much more practice (100 or more items!)

Current effect F(24, 938)=6.4820, p=0.0000

- 0.0 to 0.4
- 0.4 to 0.5
- 0.5 to 0.6
- 0.6 to 0.7
- 0.7 to 0.8
- 0.8 to 0.9

Patient starting accuracy (severity)

Average post-treatment accuracy

To reach the same level of improvement (>90%) more severe patients need much more practice (500 or more items!)

So what does this mean clinically?

- The more we understand about population data, the more we can individualize patient treatment.
- Based on the study results, an individualized, evidence-based-practice approach result in significant patient gains.
- How could data like this change your clinical decision making?
  - Development of technology for more data and more scientific clinical decisions.

Thank you!

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