

Serious games for upper limb rehabilitation after stroke: a meta-analysis

Ioannis Doumas, Gauthier J. Everard, Stephanie B. Dehem, Thierry M. Lejeune

Introduction

- Increasing stroke numbers $\Rightarrow$ Higher rehabilitation demands
- 2/3 of stroke survivors maintain upper limb paresis $\Rightarrow$ Few attain complete recovery
- Recent technological progress in hardware $\Rightarrow$ Opportunities in self- & tele-rehabilitation

Methods

- PRISMA guidelines
- P:** Adult stroke survivors
- I:** Serious games implemented on robots, motion-capture systems, computers, tablets, smartphones
- C:** Conventional therapy
- O:** **Body Function (FMA)**; **Activity (ARAT, BBT, WMFT)**; **Participation (SIS-participation subscale)**
- S:** Randomized Controlled Trials (RCT)
- Content analysis based on the consolidated set of 11 neurorehabilitation principles (Maier 2019)

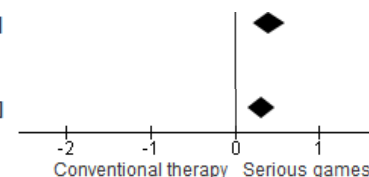
- Massed practice
- Dosage
- Structured practice
- Task-specific practice
- Variable practice
- Multisensory stimulation
- Increasing difficulty
- Explicit feedback
- Implicit feedback
- Avatar representation
- Use of the paretic limb

Results

Body function

37 RCT

Subtotal (95% CI) $\geq 8/11$	513	509	70.4%	0.41 [0.22, 0.61]
Heterogeneity: $\tau^2 = 0.10$; $\chi^2 = 45.97$, $df = 23$ ($P = 0.003$); $I^2 = 50\%$				
Test for overall effect: $Z = 4.18$ ($P < 0.0001$)				
Total (95% CI)	692	687	100.0%	0.32 [0.16, 0.48]
Heterogeneity: $\tau^2 = 0.10$; $\chi^2 = 64.45$, $df = 34$ ($P = 0.001$); $I^2 = 47\%$				
Test for overall effect: $Z = 3.87$ ($P = 0.0001$)				
Test for subgroup differences: $\chi^2 = 5.73$, $df = 1$ ($P = 0.02$), $I^2 = 82.6\%$				



Activity

25 RCT

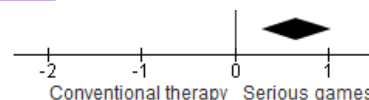
Subtotal (95% CI) $\geq 8/11$	310	316	64.8%	0.42 [0.12, 0.72]
Heterogeneity: $\tau^2 = 0.23$; $\chi^2 = 44.91$, $df = 16$ ($P = 0.0001$); $I^2 = 64\%$				
Test for overall effect: $Z = 2.77$ ($P = 0.006$)				
Total (95% CI)	491	505	100.0%	0.25 [0.05, 0.46]
Heterogeneity: $\tau^2 = 0.14$; $\chi^2 = 54.04$, $df = 24$ ($P = 0.0004$); $I^2 = 56\%$				
Test for overall effect: $Z = 2.39$ ($P = 0.02$)				
Test for subgroup differences: $\chi^2 = 6.35$, $df = 1$ ($P = 0.01$), $I^2 = 84.2\%$				



Participation

4 RCT

Total (95% CI)	60	60	100.0%	0.66 [0.29, 1.03]
Heterogeneity: $\tau^2 = 0.00$; $\chi^2 = 2.83$, $df = 3$ ($P = 0.42$); $I^2 = 0\%$				
Test for overall effect: $Z = 3.49$ ($P = 0.0005$)				



- Better overall effects for serious games complying with **at least 8/11** neurorehabilitation principles
- Long-term effect retention for upper limb function

Conclusions

- PICOS** ✓
- Future development of stroke-specific serious games should further take into consideration the consolidated set of neurorehabilitation principles