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### THE EVOLUTION OF NEUROSURGERY



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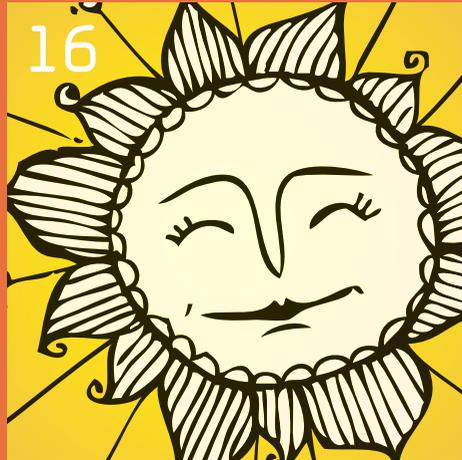
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# IPHONE® RESOURCES IN NEUROSURGERY



Nickalus R. Khan, MD



Tyler Auschwitz, MD



Asim F. Choudhri, MD



Paul Klimo, Jr., MD, MPH

In the *Congress Quarterly* Winter 2013 issue Drs. Colen and Zalatio provided a review of smartphone applications in neurosurgery by subjectively using the survey responses a group of neurosurgery fellows. The purpose of this article is to review the clinically relevant iPhone® applications in neurosurgery using an equation based on rating scores, years since release, and total number of ratings received in the application store for applications solely related to neurosurgery to supplement the work presented in the Winter 2013 issue.

A search was performed in April of 2013 in the iTunes® Application store for all applications related to neurosurgery. The iTunes® App store was queried with a combination of the following terms: neurosurgery, neuro, surgery, neurology, and brain. Inclusion criteria included applications based in the English language, applications which had direct relation to neurosurgery or indirect relation to neurosurgery (e.g., Neurological Exam, GCS Grading Systems, NIHSS grading systems). Exclusion criteria included applications not based in the English language, applications related to

meetings or conferences, applications related to private physician practices, or applications that were solely related to basic science or neuroscience research.

Articles were ranked according to a formula that accounted for the application rating, total number of ratings, and years since release on iTunes®. The application rating is a reported score ranging from 1 (lowest) to 5 (highest) stars that iTunes® users can evaluate applications with. In order to control for applications that may have high ratings but very few total numbers of ratings the total number of ratings was multiplied by the square of the rating value. The squared value of the rating value allows for control over 'negative rating bias.' It is widely known that apps often get more negative than positive ratings, therefore we consider an app with 5 ratings of 4 greater than an app with 20 ratings of 1, although both yield the same number of rating points. Since ratings occur over time, we placed the years since an application was published in the denominator of our equation to compare apps with different release dates. The applications were then ranked in descending order based on this scoring system. The following equation summarizes how each unique application score was determined.

$$\text{Application Score} = \frac{(\text{iTunes}^{\circledR} \text{ Rating})^2 \times (\# \text{ of Ratings})}{\text{Years since release}}$$

The initial search returned 43 iPhone® applications. Of these 43 applications, there were 31 applications educational in nature, 4 scoring systems, 4 multifunctional applications, 2 board review applications, and 2 applications related to peer reviewed journal applications (e.g., JNS, SNI). Of the 43 applications 14 had at least one rating in the iTunes® application store. The overall application score was  $106 \pm 409$  with a median of 0. The top 10 applications in our evaluation are shown in Table 1. The average cost of an application was  $\$14 \pm \$28.6$  with a median of  $\$2.99$  (range  $\$0.00$  to  $\$149.99$ ). The average overall rating of an application was  $1.23 \pm 1.74$  stars with a median of 0 and the average number of ratings was  $13.2 \pm 45.7$  (range 0 to 299) with a median of 0. The average rating of applications that had at least one rating was  $3.4 \pm 0.94$  with a median

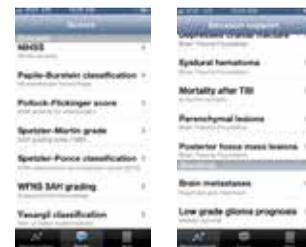
of 3.5. There was no significant correlation between application rating and the cost of an application in using a bivariate analysis ( $r = -0.241$ ,  $n = 43$ ,  $p = 0.115$ ).

Brief descriptions are given for each of the top 5 applications determined by our scoring system. These descriptions provide the reader with a descriptive list of the iPhone® applications that are currently both the highest rated and most used applications related to neurosurgery in the iTunes® store.



## Rank # 1: Neuromind

Neuromind is an application developed by Pieter Kubben in 2010 that is now in its 2nd version (v. 2.1). This free application has a very broad list of scoring systems, anatomical images, decision-making tools, and anatomical images. This application has consistently been one of the highest ranked iPhone® applications on iMedicalapps.com. This application has the highest number of ratings out of all applications analyzed and is one of the most widely used and accepted iPhone® applications within neurosurgery. The survey performed by Dr. Colen and Dr. Zalatio reported that most respondents may have had this application, but did not use it frequently. Our results show that this application is the overall most rated and highest rated application out of all applications reviewed in this study.



## Rank #2: Neurosurgery Survival Guide

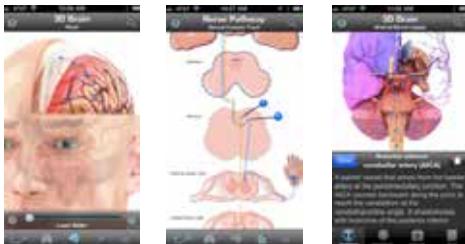
Neil Roundy released the Neurosurgery Survival Guide in 2011. The latest version of this application at the time of this study is v. 1.14. This application is similar in nature to Neuromind, consisting of 8 categories as follows: Basics, Neurocritical Care, Procedures, Protocols, Pediatrics, Trauma, Learning, and In the OR. This application lists various graphics, scoring systems, and practical guides for physicians at all levels of training. The cost of this application is  $\$7.99$ .

**Table 1.** Top 10 iPhone® applications related to Neurosurgery

Application	Release Date	Version	Cost	Author	Rating	# of Ratings	Category	Rating Score	Rank
Neuromind	2010	2.1	\$0.00	Pieter Kubben	3	299	Multiple	2691	1
Neurosurgery Survival Guide	2011	1.14	\$7.99	Neil Roundy	4.5	19	Multiple	385	2
Pocket Brain	2013	2.2	\$9.99	eMedia	4	19	Educational	28	3
SLIC	2012	2.00	\$0.00	Pieter Kubben	2.5	46	Scoring System	288	4
NIH Stroke Scale from Stat Coder	2010	1.30	\$0.00	Austin Physician Productivity, LLC	3.5	14	Scoring System	172	5
Neuro Tool Kit	2010	2.99	\$2.99	Kent Ellington	4	30	Scoring System	40	6
Neurosurgery: What's the Data?	2012	1.01	\$3.99	Limbix, LLC	5	6	Journal	150	7
iSpine Care	2010	1.4.1	\$59.99	Anatomate Apps	4	28	Multiple	149	8
Helsinki Microneurosurgical Atlas	2012	1.6.7	\$0.00	B. Braun Melsungen AG	4.5	5	Educational	101	9
Anatomy of the Brain	2009	1.0.4	\$2.99	Simpaddico, LLC	2.5	42	Educational	66	10

**Rank #3: Pocket Brain**

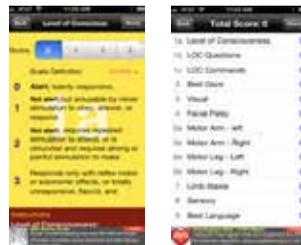
Pocket Brain is a neuroanatomical educational application. This application has several layers of 3D animations, clinical cases, cross-sections, and nerve-pathway animations. This application has received several positive reviews from iMedicalapps.com. This application could have benefit in describing anatomy and pathology to patients in clinical practice. The cost of this application is \$9.99.

**Rank #4: SLIC**

SLIC is a scoring system for the commonly used Sub-axial Cervical Spine Injury score. This free application is a simple scoring system using the SLIC system first proposed by Vaccaro et. al. in 2007. This application walks the user through each of the criteria described by this scoring system.

**Rank #5: NIH Stroke Scale from Stat Coder**

Austin Physician Productivity, LLC, released the NIH Stroke Scale application in 2010. This free application presents a succinct and well-organized and detailed application to calculate the NIH Stroke Scale.



The applications listed in our 'Top List' are dependent on the amount that iTunes® users rate the applications. The most frequently used iPhone® apps within our institution are Neuromind and the Neurosurgery Survival Guide. The SLIC scoring system and NIH Scoring system applications (Rank # 4 and 5) while helpful, provide no additional information or use outside of either the Neuromind or Neurosurgery Survival application packages.

The iPhone® is currently the most widely used smartphone platform in the healthcare setting and has the greatest number of literature reports regarding the medical use of this technology. As other smartphone platforms become more mature and are used more widely in a clinical setting, an objective evaluation of the medical and neurosurgical focused applications for these platforms may be warranted.

The study of medicine in the 21<sup>st</sup> century brings with it a unique set of problems. There

has been an exponential rise in biomedical information and resources. There now often exists too much information rather than too little information to address our questions. Methods for addressing the large amount of resources efficiently, timely, and accurately are essential as we move into the future of evidence-based medicine. This study evaluates the resources available for one of the most commonly used technologies within neurosurgery, the iPhone®. Caution must be used when correlating the cost of an application to its practicality. The results of our study show that on average applications that are free often provide more and higher user ratings than the paid applications and no significant relationship between cost and rating exists.

The list of highest rated applications are stratified by factors that include ratings on the App Store. It is not possible to identify which applications may have artificially inflated scores due to developers attempting to create false reviews in their favor, however, the App Store has policies which attempt to prevent, or at the very least limit, this activity.

It is worth noting that the regulatory nature of medical-oriented smartphone applications has not yet been established. None of the applications described have United States Food & Drug Administration 510k approval.

Tools like the ones mentioned in this study are valuable to the future and current generation of physicians who need not only the mastery of surgical skill and knowledge, but also the mastery of technology and digital information as it relates to the practice of evidence based medicine. ❏