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Review

Neurosurgery Apps: Novel Knowledge Boosters

Nöroşirürji Uygulamaları: Yeni Bilgi Artırıcılar

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ABSTRACT

AIM: The utilization of technology for purpose of imparting knowledge, especially in high-end branches like neurosurgery, has gained prominence in the contemporary academic scenario. The technological advancements have brought about outstanding transformation to education and patient care. The connectivity through smartphone applications (apps) has transcended the spatial and temporal limitations, thereby enabling easy access to virtually infinite storehouse of knowledge. Although there are numerous neurosurgery related apps, yet there is still a dearth of quality apps that may serve the purpose.

MATERIAL and METHODS: Relevant apps were searched and evaluated on PlayStore and Apple App store, based on their content, user interface, performance, and utility in routine practice and compared with their cost, size and popularity. They were categorized into apps related to textbooks, scoring systems, patient education, operative procedures, blogs, journals, conferences and promotional.

RESULTS: 159 relevant apps were hosted on App stores; 54.7% apps were free of cost. "Neuromind" was the most downloaded app because of its simplicity, free access and applicability. Students and practitioners prefer various apps linked to scoring systems, textbooks and operative illustrations. Apps have helped patients in better understanding of their diseases and management options.

CONCLUSION: Development of web-based technologies has divided medical professionals into traditional and modernized learners. Mobile apps permit knowledge to be structured visually to facilitate its easy diffusion in the peer community. A technologically demanding branch like Neurosurgery inevitably needs innovative, cost effective apps with trust worthy content. Relevant apps have a high potential to be used as an excellent resource for effectual neurosurgical education beyond the limitations of time and place.

KEYWORDS: Smartphone, Neurosurgery apps, Education, PlayStore, App store

ÖZ

AMAÇ: Özellikle nöroşirürji gibi üst düzey dallarda bilgi vermek için teknoloji kullanımı günümüzdeki akademik ortam içinde önem kazanmıştır. Teknolojik gelişmeler eğitim ve hasta bakımı açısından olağanüstü bir dönüşüm geçirmiştir. Akıllı telefon uygulamaları (app'ler) yoluyla bağlanabilirlik, uzaysal ve zamansal sınırlamaları aşmış ve hemen hemen sonsuz bir bilgi ambarına kolay erişimi mümkün kılmıştır. Şu anda çok sayıda nöroşirürji uygulaması olsa da işe yarayacak kaliteli uygulama sıkıntısı vardır.

YÖNTEM ve GEREÇLER: İlgili uygulamalar, PlayStore ve Apple App mağazasında araştırılmış ve içeriği, kullanıcı arayüzü, performansı ve rutin uygulamadaki faydası açısından değerlendirilip maliyet, büyüklük ve popülerlik açısından karşılaştırılmışlardır. Bunlar kitaplar, puanlama sistemleri, hasta eğitimi, operatif işlemler, bloglar, dergiler, konferanslar ve promosyonel uygulamalar şeklinde sınıflandırılmışlardır.

BULGULAR: App mağazalarında 159 ilgili uygulama bulunmuş ve bunların %54,7'sinin ücretsiz olduğu izlenmiştir. Basitliği kolay erişimi ve uygulanabilirliği açısından en çok indirilen uygulama "Neuromind" olmuştur. Öğrenciler ve uygulayıcılar puanlama sistemleri, kitaplar ve ameliyat çizimleriyle bağlantılı çeşitli uygulamaları tercih etmektedir. Uygulamalar hastaların hastalıkları ve tedavi seçeneklerini daha iyi anlamalarına yardımcı olmuştur.

SONUÇ: Web tabanlı teknolojilerin gelişmesi tıp uzmanlarını geleneksel ve modern öğrenciler olarak bölmüştür. Mobil uygulamalar bilginin bilimsel toplulukta kolay dağılmasını sağlayacak şekilde görsel olarak yapılandırılmasını mümkün kılmaktadır. Nöroşirürji gibi teknolojik açıdan zorlu bir dal tabii ki güvenilir içerikli yenilikçi ve maliyet etkin uygulamalar gerektirecektir. İlgili uygulamaların zaman ve yer sınırlamalarının ötesinde etkili nöroşirürji eğitimi açısından mükemmel bir kaynak olarak kullanılmak üzere yüksek potansiyeli vardır.

ANAHTAR SÖZCÜKLER: Akıllı telefon, Nöroşirürji uygulamaları, Eğitim, PlayStore, App Store

ABBREVIATIONS: 2D: 2 dimensional, **3D:** 3 dimensional, **Apps:** applications, **F:** free, **.flv:** flash video, **GB:** gigabyte; **HTML:** hypertext markup language, **iOS:** iPhone operating system, **Kb:** kilobyte, **MB:** megabyte, **.mpeg:** moving picture expert group, **QR:** quick response, **UPC:** universal product code, **USD:** United States Dollar

INTRODUCTION

The 21st century has been fortunate to witness the greatest and unanticipated transformation in the domain of communication modalities that is manifested in widespread usage of mobile communication devices and smartphone applications (apps). Though primarily introduced for entertainment, these apps have expanded into every aspect of life and productively into education and health care. The introduction of apps has brought world from screens to "palms". Every smartphone platform like Android (PlayStore), iOS (App Store), Windows Phone and Blackberry hosts variety of apps, which link to medical education.

Due to financial and regional constraints, it becomes challenging to provide an opinion on the preferred mobile operating system (OS) among neurosurgeons. Android-based smartphone and devices occupy 68.4% of mobile phone market owing to its popularity in Asian countries. On the other hand, iOS is popular in American continent and Australia, occupying 19.4% of global mobile market (6). It is difficult to find useful app among the wide cafeteria choices available. A critical analysis of these apps leaves one with an unsatisfactory note (15). These apps impart information regarding diseases and health care to patients, whereas provides guidelines for patient examination, diagnosis, management and operative procedures to neurosurgeons.

The ever-increasing number of apps and their expedient availability has added more confusion. It is difficult to choose the desired app providing relevant and updated information. Considering these difficulties, it is undeniable that there exists a dire need of a comprehensive and an all-inclusive review of available apps, which can modestly serve in guiding the community to sort out appropriate apps of their utility from the pandemonium of app markets.

MATERIAL and METHODS

Apps were searched on PlayStore (Android market) and App Store (iOS market) using the phrases "Neurosurgery", "Neurological Surgery", "Neuro Surgery", "Spine", "Neurosurgical Operations" and reviewed in April 2014. These were further evaluated on pre-defined parameters of Android versus iOS, free versus paid, cost, developer ratings, installations, synchronous versus asynchronous content (on the number of devices; data available only for Android devices), size, content user ratings, update history, and reviewers' comments. All free apps were individually evaluated after installing them over the relevant operating systems, to rate their content and performance. The paid apps were also evaluated on the basis of their performance with trial versions, when available or on the extensive customer review.

The number of installations of an app is an indirect evidence of its acceptance and popularity among users (13). After downloading an app, users rate and comment on the them (12). Any new user may view the average user ratings of these apps on the statistics page in 'Google Play Developer Console'. At the time of publishing an app, developer provides a maturity rating for a selected group of users. It should be followed according to 'Google Play instructions' (1).

In App store, user ratings are not available and one has to go through the content and user interface for deciding the suitability of the app. Developer ratings in iOS are categorized in 4+, 9+, 12+ and 17+, as per the viewer age suitability for the content (16). Software version is the process of assigning numbers to unique states of application, which also provide details of updates (17).

RESULTS

Total 159 apps were considered relevant on both the markets. A large number of apps were not directly related to neurosurgery (viz. chiropractic maneuvers, acupuncture, fiction novels, stories, blogs etc.) hence were omitted. Spine category hosts maximum number of irrelevant apps in both markets, adding confusion to the user. The phrase "Neurological surgery" provided least number of relevant apps (Table I, II). 101/159 (63.5%) was available in Apple stores and rest (58=36.5%) in PlayStore. Overall, neurosurgery apps are quite less in number as compared to apps directed to general medical practice like 'Calculate by QXMD' rated 4.6/5 by 1769 users (4). The appropriate apps were further evaluated and compared on pre-defined criteria (Table III, IV).

Application Category

Apps were further categorized into seven groups namely score calculators, clinical practice, operative procedures, journals, conferences, promotional, and interactive forums / blogs. Some apps catered to other sub-specialties like neuropsychiatry, neurology (e.g. eHand Neurology) and neuro-critical care (e.g. Neurointensive Care guide).

Free Versus Paid

87/159 (54.7%) apps were free of cost. Interestingly, PlayStore hosts 1.34 times more free apps than paid apps. The costliest apps on App Store were iSpineOperations and iSpinePainManagement, each at USD75. The priciest one on PlayStore was 'Neurosurgery: 1000MCQ', costing USD 14. Most of the paid apps available on PlayStore ranged between USD 0.7 to 4.5 while on App Store between USD 0.7 to 7.7 (Table III, IV).

Size of App

Size of an app is expressed in standard formats of kilobyte (kB), megabyte (MB) and gigabyte (GB). In view of the limitations posed by operating systems, most of the apps were in the size range of 1-30 MB. However, few apps were considerably large in size such as iSpineCare (1.7GB) and Dynamic Spine (1.5GB) running on iOS based systems (Table III,IV). Interestingly, the costliest apps were neither largest nor most popular. There was no correlation between size, cost and quality of an app.

DISCUSSION

Most Popular Apps

With each passing day, new medical apps are added to the

Table I: Recommended App on App Store and PlayStore

Category	App Store	PlayStore
Clinical Practice App	SOAP For iPad, AANS Grand Rounds,	Neurosurgery Survival Guide, AANS Grand Rounds, Neuroslice
Procedural App	iSpineCare, Neurosurgery Procedural Atlas,	Craniotomy
Score and Calculators	Neuromind, Neurotool Kit	Neuromind, NIHSS, Glasgow Coma Scale Free
Journal	SNI, JNS, Neurosurgery	SNI, JNS
Promotional App	Neuro Helsinki	-

Table II: Neurosurgical Blogs Accessible with Respective Apps

App provider	Blog
Neurocirurgia Brasil	www.neurocirurgiabr.com
Neurosurgery	www.neurosurgic.com
Neurosurgery (Journal)	http://neurosurgerycns.wordpress.com/
Neurosurgery apps and decision support	http://DigitalNeurosurgeon.com
Surgical Neurology International (journal)	http://surgicalneurologyinternational.com/blog/

market but apps with updated and comprehensive content are still a few. With around more than 0.2 million downloads, Neuromind tops the list among all the apps dedicated to Neurosurgery (15,19) (Table III). Most of these popular apps share a unique combination of being illustrative with easy user interface and comprehensive coverage of the topics and regular revisions.

Score-Calculator Apps

Residents and trained neurosurgeons most frequently use apps related to 'scoring systems', followed by apps for anatomical illustrations (8). Most of the apps were dedicated to particular scoring system only like SimpliGlasgow or 'GCS Free app' for calculating Glasgow Coma Score and 'NHISS' app for stroke severity calculation. However, a few apps such as Neuromind systematically deal with all commonly used scoring systems in clinical practice.

Clinical Practice Apps (Neuroanatomy, symptomatology, treatment guidelines etc.)

A significant number of apps are dedicated to basic neurosurgical sciences such as neuroanatomy, patient examination and treatment, approach for management and interactive case scenarios. Some of these apps provide three dimensional (3D) visualization of cranial and spine anatomy, radiological correlation and comments over controversies of management viz. Spinal Cord Trauma (iOS) app and EASS.live app (AO Spine society app on PlayStore). Neuroslice is another very popular app among first year residents with interactive demonstration of radiological images of brain in axial, coronal and sagittal sections. Apart from these, one can also find useful apps for preparation of various board examinations e.g. AANS Board Review and Neurosurgery, 1000MCQ (Figure 1).

Procedural App

Neurosurgical operations are complex and demand highest degree of accuracy in their execution. Apps dedicated to specific spine and cranial operative procedures demonstrate the intricacies of surgical steps and operative minutiae with edited video clips and narrative descriptions. Such apps (e.g. AANS Grand Round) link to operative videos library through their domain. Most of these videos are in Flash video (.flv) or 'Moving Picture Expert Group' (.mpeg) format and are hosted on popular platforms like YouTube or vimeo. It is now encouraging to find that most of these platforms are supporting their content in 'Hypertext Markup Language' (HTML5) format (e.g. SNImobile) (8). HTML5 is device independent, which makes it a potential candidate for cross platform mobile applications. There are a few apps dedicated for functional neurosurgery such as Stereocheck that helps in image based target localization and cross check of fiducial markers.

Journal Related Apps

Some popular journals have their dedicated apps for both platforms. A few journals were free access providing full content (e.g. SNI for Surgical Neurology International) while rest were providing limited content like abstract only for free users (e.g. Neurosurgery and Journal of Neurosurgery). The content of these apps was easy to navigate and downloadable providing up-to-date information about advances in Neurosurgery (Figure 2A,B).

Apps in Foreign Languages

English is the preferred language of communication used by majority of neurosurgery apps. However, a few apps are available in other popular languages as well such as Turkish, French, Spanish, Chinese and Portuguese etc. These apps

Figure 1: User interface of **A)** Neurosurgery Survival Guide app; **B)** AANS Grand Rounds.

Figure 2: A) Official app and **B)** User interface of Turkish Neurosurgery.

carry their special worth in other parts of the world, where education can be imparted in their native language e.g. iNeurochirurgiae and Turkish Neurosurgery.

Apps Linking to Blogs

Blog, which is a short form of 'weblog', is a virtual diary connecting the reader to material published by a person or a community. With their subscription, one can get an update of their content on email, also known as 'feeds'. Some neurosurgical apps link them to various blogs related to their website or their social networking forums e.g. Facebook, Twitter etc. (Table II) (9).

Table III: Apps for iOS Based Smartphones (Based on Inputs from App Store)

S No.	App Name	Cost (USD*)	Version	Size (MB)
Category: Clinical Practice App				
1	@Hand: Treatment Strategies in Neurology	33.84	1.0	2.1
2	1000 Neurology Dictionary and Glossary of Terms	2.61	1.7	24.7
3	3D Human Spine	0.84	1.0	34.9
4	3D Human Spine HD	2.61	1.0	24.0
5	3D Medical Human Spine HD	2.61	1.01	24.8
6	3D Medical Human Vertebral Column HD	2.61	1.0	26.2
7	3D Nervous System	0.84	1.0	43.1
8	3D Neuro System	12.15	1.2	24.6
9	3D Pelvis Spine Pins	0.84	1.0	36.7
10	3D Spine Anatomy	0.84	1.0	37.3
11	AANS Grand Round	F	2.31	10.8
12	All Spine Disorders	1.69	1.0	5.8
13	All Visibility Spine	0.84	1.0	34.9
14	Anatomy Spine	0.84	1.0	55.9
15	Axis Atlas and Sacrum 3D	0.84	1.0	43.6
16	Build-A-Brain Explorer	1.69	1.0	52
17	Dynamic Spine	16.9	1.0	1.5GB
18	eHand: Neurology	33.84	1.0.0	1.9
19	iCranialNerves	6.92	1.1	189
20	iNeuro	6.92	1.1	144
21	iSpinePainManagement	75.38	1.2.1	968
22	MHSI	F	1.3	13.8
23	mLumbarAnatomy	2.61	1.3.1	19.6
24	mLumbarDegenerative DiscDisease	1.69	1.3.1	58.2
25	mLumbarDiscHerniation	1.69	1.3.1	53.1
26	Neurointensive Care Guide	4.15	1.0.3	3.9
27	Neurology Multilingual	0.84	1.1	1.8
28	Neurorad	16.9	2.1	104
29	Neuroradiology Multilingual	0.84	1.1	5.8
30	Neurosurgery: Conditions & Treatment	0.84	1.3	14.5
31	Oxford Handbook of Neurology	41.5	1.5.0	9.3
32	Pocket Brain	8.46	2.4	132
33	SANS Boards	33.84	1.0.2	4.5
34	SOAP For iPad	41.5	1.1	3.9
35	SOAP Lite	0.84	1.1	3.7
36	Spinal Cord Trauma	4.15	1.0	9.3
37	Spine Care	F	2.0	11.2

Table III: Cont.

38	Spine Conditions & Treatment	1.69	1.0	12.1
39	Spine Decide Patient Education for Healthcare	F	4.0.2	137
40	Spine Glossary	1.69	1.0	1.5
41	Spine HD	2.61	1.0	59.6
42	Spine Imaging Case Review	16.9	1.0	85.2
43	Spine Pro III	8.46	3.7	1.4GB
44	SpineEffects	F	1.0	35.8
45	The Complete Human Brain PRO	41.5	1.0	22.9
46	The Kinetic Spine	F	1.0	24
47	Vertebra Structure 3D	0.84	1.0	43.2
48	SLIC	F	2.0	5.0
Category: Neurosurgical Procedure				
49	iNeuroMobile	F	1.0.2	23.4
50	iSpineCare	59.99	1.4.1	1.7GB
51	iSpineOperations	75.38	1.3.2	1.3
52	mLumbarLaminectomy	2.61	1.2.1	66.5
53	mLumbarMicroDiscectomy	2.61	1.2.1	71.2
54	mLumbarPosteriorInterbodyFusionCage	2.61	1.2.1	173
55	NeuroClin Instruments	F	1.0	22.3
56	Neurosurgery: A Procedural Atlas	2.61	1.0	6.2
57	OOTApp	F	1.0.0	8.4
58	StereoCheck	8.46	1.3	1.2
59	Thomale Guide Application	F	1.1.1	14.2
60	VCath	F	1.02	26.7
Category: Score Calculators				
61	Neuro Toolkit	2.61	2.999	4.5
62	Neuromind	F	2.2	13.4
63	SimpliGlasgow	0.84	2.0	52.8
64	SLIC	F	2.0	4.7
Category: Neurosurgery Journals				
65	GIS	F	1.2	2.3
66	JNS App	F	2.0	4.7
67	Journal of Spinal Disorders	F	1.1	7.5
68	Neurosurgery	F	1.3	5.2
69	Spinal News International	F	1.0	12.9
70	Spine	F	1.2	9.4
71	Turkish Neurosurgery	F	6.4	2.7
72	The Spine Journal	F	3.8.10	5.5
73	SNI International	F	1.1	4.0
Category: Neurosurgery Promotional				
74	Aesculap Spine Cervical	F	1.6.7	13.3
75	Aesculap Spine MIS Thoracolumbar	F	1.7.4	8.1
76	AAOS eBooks	F	3.3.3	5.3
77	Aesculap Neuroendoscopy	F	1.6.7	15.1

Table III: Cont.

78	AuroraSpine	F	1.1	20.8
79	BASS Access	F	1.2	4.6
80	coflex	F	3.0.0	12.1
81	DePuy Synthes eModels	F	AD	20.6
82	DePuySynthes International	F	3.01.1	3.7
83	mLumbarPosteriorInterbodyFusionCage	2.61	1.2.1	173
84	Paradigm Spine	F	3.0.0	11.6
85	SI-LOK	F	1.0	24.4
86	Stryker IVS for iPad	F	1.1.1	777
87	Thieme Bookshelf	F	3.3.1	3.4
88	Yellosteps 3D Viewer	F	1.03	17
89	Neuro Helsinki	F	1.054	12.6
Category: Neurosurgery Conferences				
90	10th ECE, London2012	F	1.0	6.5
91	30th IEC Montreal 213	F	2.2.1	12.3
92	CNS 2013 Annual Meeting Guide	F	1.6	38.9
93	CSRS 2013 Mobile	F	4.0	2.0
94	DGNC 2013	F	1.1	18
95	EuroSpine HD	F	3.1	36.8
96	ISASS HD	F	3.0.2	21.7
97	LINNC	F	3.6.0	6.7
98	NASS Annual Meeting 2012	F	1.1	14
99	NASS Annual Meeting 2013	F	1.4	2
100	SNIS 2012 HD	F	2.2	12
101	SNIS IESC/CV Section Annual HD	F	2.2	11.3

App, *application;* ***F,*** *free of cost;* ***MB,*** *megabyte;* ****USD,*** *United States Dollar.*

Apps Linking To Conferences

These are extremely useful apps that link to the upcoming events of Neurosurgical Societies, and provide information about schedules, lectures and map directions for that particular event. They find their special favor among the foreign delegates as they help them with roadmap, economic hotels and conveyance options, local customs and commonly used phrases in non-native lands (Table III, IV). The hosts thoughtfully provide these apps for the registered users. In an effort to continue medical education, app can be directed to the archived educational content presented and discussed during the conference otherwise, these apps loose their worth after the event, and their removal would be a responsible act by the conference organizers.

Use of Quick Response (QR) code in apps

QR code is a trademark of two-dimensional (2D) matrix barcode arranged in a square grid on a white background, which can be read by an imaging device and processed over Internet. It provides quick access, fast readability, and greater storage capacity compared to traditional standard 'Universal Product Code (UPC)' barcodes. A few apps like SNI mobile (Figure 3) (14), and Neurosurgery are using QR codes for easy access for their published material (18).

Apps With 3D Content

Some apps (e.g. 3D Spine Anatomy, Vertebra Structure 3D) provide anatomical and procedural illustration with the help of 3D models for better understanding of the subject. Such apps are in demand but they occupy significant space on the hard discs and require advanced operating systems for smooth performance.

Promotional Apps

This interesting segment of apps is meant for advertisement

Figure 3: An example of QR code directing to Surgical Neurology International homepage (15,19).

Table IV: Apps for Android Based Smart Phones (Based on Inputs from PlayStore)

S No.	App Name	Cost (USD*)	User Ratings	No. of Downloads	Size
Category: Clinical Practice App					
1	3D Spine Structure	0.97	0-0	10-50	29MB
2	AANS Grand Rounds	F	4.9/9	1,000 - 5,000	2.7MB
3	Craniotomy	3.34	3.85/7	100 - 500	12MB
4	Deep Brain Stimulation	F	0-0	100 - 500	3.5MB
5	EBSS.live	F	5/6	1000-5000	12MB
6	Medical-Surgical Exam Prep	4.14	0/0	100-500	552kB
7	Medrills(Spinal Cord Injury)	3.36	0-0	10-50	85MB
8	MHSI	F	5/1	100-500	2.6MB
9	my Surgical Assistant Free	F	1.8/4	1,000 - 5,000	739kB
10	My SurgicalAssistant	0.83	0-0	10 - 50	238kB
11	Neuro Exam	4.70	5.0/2	100 - 500	17MB
12	Neuro Radiology - Brain Lite	F	4.8/8	5,000 - 10,000	3.2MB
13	Neuroinfect App	4.17	5.0/1	10-50	12MB
14	NeuroInfect App	F	4.2/5	1,000 - 5,000	11MB
15	Neurointensive Care Guide	4.21	4.5/6	100 – 500	3.1MB
16	NeuroRadiology – Brain	3.42	3.8/4	100 – 500	18MB
17	NeuroSlice	F	4.5/97	50,000-100,0000	5.3MB
18	Neurosurgery	2.52	3.0/4	100-500	71kB
19	Neurosurgery Conditions & Treatment	0.84	3.0/2	50 – 100	3.6MB
20	Neurosurgery Survival Guide	5.84	4.8/27	1000-5000	21MB
21	Neurosurgery, 1000 MCQs	14.12	0-0	1-5	12MB
22	Quiz- Anatomy/Physiology Neurology	4.21	3.5/4	100 – 500	713kB
23	Skyscape (Back and Spinal cord)	12.6	0-0	50-100	831kB
24	Spinal Cord/ Nerve flash cards	F	5/2	500-1000	5MB
25	Spine Glossary	0.83	0- 0	100 – 500	1.9MB
26	Spine MD	F	0-0	100-500	4.3MB
27	Surgical Assistant	0.83	3.2/5	100 – 500	168kB
28	Traumatic Brain Injury (TBI)	4.21	5.0/4	100 – 500	4.1MB
29	SLIC	F	4.6/5	1000-5000	4.4 MB
Category: Scores Calculators					
30	Glasgow Coma Scale	0.88	0.0	10 – 50	199kB
31	Glasgow Coma Scale Free	F	4.5/42	50000-100000	278KB
32	My Neuro Torch	0.84	5/3	50 – 100	206kB
33	NeuroMind	F	4.2/112	10,000 - 50,000	12MB
34	NIHSS	F	4.7/55	10,000 - 50,000	344kB
35	NIHSS-PRO	0.82	5.0/3	50 – 100	1.0MB
Category: Neurosurgery Journals					
36	Journal of Neurosurgery Online	F	4.5/4	1,000 - 5,000	2.2MB
37	Neurocritical Care	F	5/1	100 – 500	3.6MB
38	SNI Mobile	F	3.6/7	1,000 - 5,000	3.1MB
39	Turkish Neurosurgery	F	3/3	50 - 1,00	358 kB

Table IV: Cont.

Category: Neurosurgery Promotional					
40	Neurosurgery - CIMS Hospital	F	0-0	100-500	2.2MB
41	SANS	F	0-0	10 – 50	5.6MB
42	Spine and Health Institute	F	0-0	50-100	376kB
43	Valley Spine Care	F	0-0	10-50	2.6MB
44	VTIConnect	F	5/4	100-500	2.6MB
Category: Apps Connecting to Blogs					
45	Chiari Malformation Awareness	F	1/1	100 – 500	2.9MB
46	Headache App	F	3.6/24	1,000 - 5,000	1.9MB
47	Neurosurgery	F	4/4	1,000 - 5,000	914kB
48	Neurosurgery Blog	F	5/7	1,000 - 5,000	1.3MB
Category: Neurosurgery Conferences					
49	AES AnnuMtg	F	1.6/5	100 – 500	3.6MB
50	DGNC 2013	F	0-0	100 – 500	6.5MB
51	iSASS	F	0-0	100-500	7.1MB
52	JNS 2013	F	0-0	100-500	7.4MB
53	LINNC	F	5/1	50-100	3.6MB
54	NCS 2013 Annual Meeting	F	0-0	10 – 50	2.0MB
55	SNIS 10th Annual Meeting	F	0-0	10 – 50	3.5MB
56	SNIS 2012	F	5/1	100 – 500	4.5MB
57	SNIS IESC/CV Section Annual	F	0-0	50-100	2.7MB
58	WCN 2013	F	0-0	1 – 5	8.5MB

App, *application;* ***F,*** *free of cost;* ***GB,*** *gigabyte;* ***kB****, kilobyte;* ***MB,*** *megabyte;* ****USD,*** *United States Dollar.*

purposes. Their utility varies from hospital advertisement, product information for implants (e.g. DePuySynthes International) to even appointment of a neurosurgeon. Braun (Aesculap) has separate apps for spinal and Neuroendoscopy procedures featuring operative videos involving their products and their appropriate usage. Obviously, these are free of cost with low popularity level (Table III, IV).

Patient Education Apps

A significant number of apps were available for illustrating diseases and their proposed treatment in easily understandable language for patients and relatives. Some of these apps are used by neurosurgeons for explaining patients about their disease with anatomical 2D or 3D illustrations and treatment details (Figure 4). Though such apps e.g. iSpineCare can be helpful for anyone, who wants to know about their disease, their high cost might pose a constraint to patients (Table III, IV).

Relevance of Neurosurgery App to Residents in Developing Nations

All smart apps need compatible devices for their smooth performance. Android based devices either mobile phones or pads are quite cheap (USD46) in comparison to iOS based devices (USD310). The price limitation makes Android-based devices more popular among developing countries. On an average, 3-5 neurosurgery apps (related to neurosurgery scoring systems, textbooks, operative procedures, interactive platforms and patient illustrations) are required for routine neurosurgery practice. Limited Internet access, poor technology and user support acts as a barrier for efficient usage. A certain number of relevant apps need to be purchased. This evaluation highlights the need for cheaper apps, as they are primarily dedicated for education and health care. We believe that there should be no time, place or monetary constraints for any learner of any class or creed that could limit their potential because of unavailability of learning material. Again we cannot put any limitation to the extent of knowledge one seeks at any level.

Do Smartphones Transmit Only Voice?

Though these "smart" devices (mobile phone and pads) have proven their worth for clinical communication and knowledge dispersion, few new threats have arisen because of their widespread use by clinicians. More than 20 studies have demonstrated that mobile communication devices are notoriously bugged with infective microorganisms sufficient to cause nosocomial infections (2,3,11). Smartphones being used around 27.5 times per day, stands out to be one of the most common fomite in hospital premises (20). According to

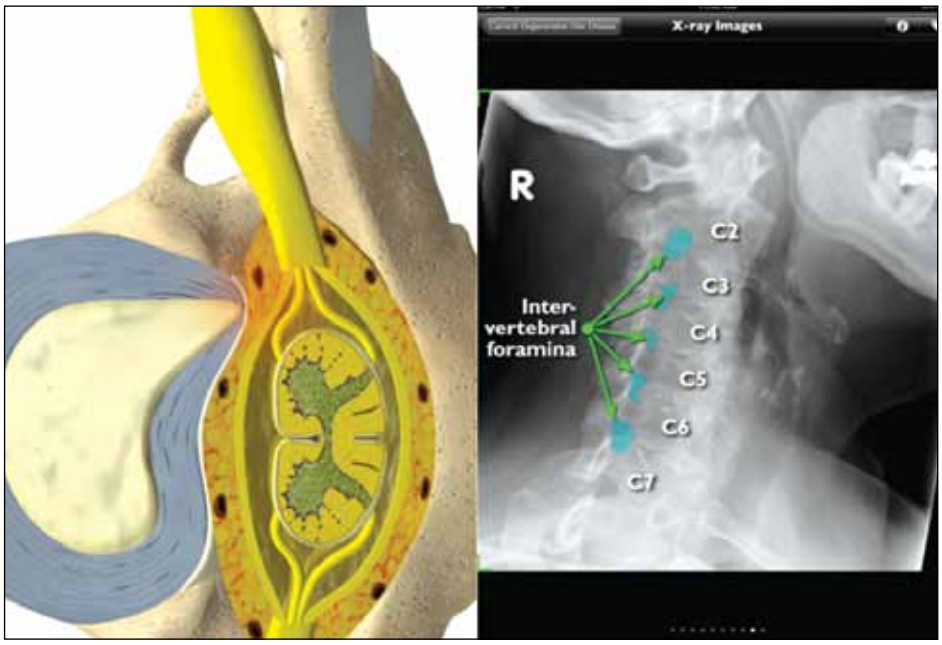

Figure 4: Snapshot of iSpineCare app showing intervertebral disc herniation causing nerve root compression.

self-reports, smartphones were used during rounds for patient care (85% residents, 48% faculty), reading/responding to personal texts/e-mails (37% residents, 12% faculty), and other non-patient care uses (15% residents, 0% faculty). This not only interrupts the flow of information but also distracts the fellow trainees and faculties (5,6) These studies warrant a need for developing 'smartphone policy' for their usage in hospital premises.

CONCLUSION

The transition of reading material from leaves to smartphones is as amazing as the evolution of mankind. With the current evaluation, we are able to suggest that good quality learning material compatible with an app is still sparse over the web. Apps with confusing similar names providing irrelevant non-reviewed data are rampant. Cheaper apps are the need of the day, as cost constraints should not be a barrier for effectual educational transfer. Any preferred app should have features of good user interface, 3D graphic content, small size, compatibility with offline usage, synchronous content support and being free of cost. Neuromind, AANS Grand Rounds, Neurosurgery Survival Guide, iSpineCare and Neuroslice are the recommended apps for routine clinical and operative practice (Table IV). There is an earnest need for a dedicated and authentic "Scholarly Search" for apps as well, directing users to quality content. Unsupervised web based learning carries a significant risk for enthusiastic learners who may not be able to access this burgeoning array of educational materials (10). Otherwise there will still be the question "Have smart apps really made neurosurgeons smarter?"

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