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The cost-effectiveness of different strategies to evaluate optic disk drusen in children

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Abstract

Purpose—To compare the costs of diagnostic work-up for optic disk drusen where ophthalmic ultrasound was performed prior to imaging and invasive studies with those where ophthalmic ultrasound was performed after such studies.

Methods—The medical records of patients <18 years of age evaluated at a tertiary referral center between 2007 and 2012 for “swollen” optic nerves were retrospectively reviewed. The main outcome measure was cost of diagnostic work-up according to Georgia Medicaid global reimbursement rates.

Results—A total of 46 children with a B-scan ultrasound–confirmed diagnosis of calcified optic disk drusen were included. Neuroimaging was performed in 23 patients, of whom 20 had the study prior to ophthalmic ultrasound. The mean cost of evaluations for patients undergoing ancillary testing prior to ophthalmic ultrasound was \$1,173; for those undergoing ancillary testing after, \$304.69.

Conclusions—Because optic disk drusen can mimic the appearance of papilledema, it is more cost-effective to perform ophthalmic ultrasonography prior to neuroimaging, especially when the patient is asymptomatic. If ophthalmic ultrasonography confirms the presence of drusen, it is more cost-effective to reassess the clinical picture before proceeding with further tests.

New technologies and an aging US population have contributed to a sharp rise in healthcare spending. Healthcare expenditures were almost 18% of the US Gross Domestic Product in 2011 and are projected to reach 20% by 2020.¹ This rising cost of healthcare spending has been deemed unsustainable, and the medical community and health policy leaders are exploring ways to reduce costs. Eliminating healthcare waste has been proposed as one way to reduce healthcare spending without compromising outcomes.²

Optic disk drusen are deposits in the optic nerve that may contain calcium, mucopolysaccharides, amino acids, ribonucleic acids, deoxyribonucleic acids, and iron.³⁻⁶

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They are generally located anterior to the lamina cribrosa and behind Bruch's membrane.⁷ Ophthalmic ultrasonography (B-scan) has been shown to be superior to computed tomography and autofluorescence in detecting optic disk drusen.⁸ Recent studies suggest that ocular coherence tomography (OCT) can effectively image and characterize optic disk drusen.⁹⁻¹¹ The relative merits of OCT and B-scan ultrasonography to detect optic disk drusen are currently being evaluated.^{9,11}

Patients with optic disk drusen often present with the appearance of swollen optic nerves, which may mimic papilledema as shown in Figure 1. This is an optic nerve photograph of a 7-year-old boy presenting with bilateral optic disk swelling and occasional headaches. Many of these patients undergo costly neuroimaging studies and lumbar puncture before more economical tests, such as B-scan ultrasound, are performed. Figure 2 shows the results of the ophthalmic ultrasound performed on the same 7-year-old patient, confirming calcified optic disk drusen. No further diagnostic testing was performed in this case because there was no concern for an intracranial process.

In this study we analyzed the diagnostic work-up of children at a university ophthalmology clinic evaluated for an apparently swollen optic nerve who were ultimately diagnosed with calcified optic disk drusen. We compared the cost of evaluations where ophthalmic ultrasound was performed prior to other studies to the cost of evaluations where ophthalmic ultrasound was performed after other studies in an effort to determine whether the order of diagnostic studies affects the total cost of the evaluation.

Methods

The medical records of patients <18 years of age presenting to the Ophthalmology Department of Emory University between 2007 and 2012 were retrospectively reviewed. Patients were selected by ICD-9 code 377.21, "Drusen of the Optic Disc." Patients who did not have B-scan ultrasound confirming optic disk drusen were excluded, as were those with studies or notes that were not available for review through electronic medical records. Patients with both confirmed optic disk drusen and papilledema were included.

Data collected included clinical symptoms, examination findings, and diagnostic testing and results. We noted whether the patients had any of the following subjective complaints suggestive of increased intracranial pressure: headache, transient visual obscurations, pulsatile tinnitus, and diplopia as well as whether they were asymptomatic. Current procedural terminology codes were used to determine the Georgia Medicaid global 2012 reimbursement for the diagnostic work-up obtained.

Patients were divided into two groups: those who had ophthalmic ultrasound prior to other diagnostic studies, such as neuroimaging and/or lumbar puncture (group 1) and those who had ophthalmic ultrasound after other diagnostic studies (group 2). The total cost of procedures divided by the total number of patients yielded the average cost of evaluation. The average cost of evaluation as well as the standard deviation was calculated for each group.

Results

A total of 46 patients who had optic disk drusen confirmed by ultrasound were included. As shown in Table 1, 20 patients had ophthalmic ultrasound prior to other studies (group 1), and 26 had ophthalmic ultrasound after other studies (group 2). The mean age of patients in group 1 was 12.30 years (range, 7-17 years); of those in group 2, 12.05 years (range, 5-17 years). Most of the patients were female (group 1, 69%; group 2, 75%). The breakdown of different types of neuroimaging is shown in Table 1. Prior to ophthalmic ultrasound, 20 patients had neuroimaging, and 7 had lumbar puncture. Neuroimaging was performed on 3 patients after ophthalmic ultrasound because there was concern for disk edema along with optic disk drusen. One patient had a 0.6-0.9 log unit afferent pupillary defect. The second patient had swollen optic nerves bilaterally but unilateral ultrasound confirmed optic disk drusen in the setting of concerning symptoms. The third patient had a suspicious clinical picture despite the disk drusen confirmation. Eight patients underwent neuroimaging prior to B-scan ultrasonography even though the patients did not have any symptoms suggestive of increased intracranial pressure and had normal eye examinations.

Table 2 details the cost, in Georgia Medicaid dollars, of different studies and tests administered to patients in this study as well the costs of evaluations where ophthalmic ultrasonography was performed prior to and after neuroimaging. The mean cost of evaluations for patients when ancillary testing was performed prior to ophthalmic ultrasound was $\$1173.24 \pm \409.09 (range, \$496-\$2070) versus $\$304.69 \pm \636.03 (range, \$84-\$2070) when ancillary testing was performed after ophthalmic ultrasound.

Discussion

This study aimed to determine whether the order of diagnostic testing affected the total cost of the evaluation. We found that the mean cost of the diagnostic work-up for optic disk drusen was over three times more expensive using 2012 Georgia Medicaid dollars when neuroimaging and/or lumbar puncture was performed prior to ophthalmic ultrasound. Possible reasons for physicians ordering neuroimaging and other studies prior to ophthalmic ultrasound include lack of access to ophthalmic ultrasonography, shortage of ancillary staff trained to detect optic nerve head drusen, and a desire to rule out serious intracranial pathology for medicolegal reasons.

Given the societal need to contain rising healthcare expenditures, developing more cost-effective ways to evaluate patients is essential. Medical specialties are working on reducing costly studies in favor of more affordable ones by creating top 5 lists of cost-effective recommendations.⁵ On the top 5 list for both internal medicine and family medicine is the recommendation to not perform imaging for low back pain with a duration of 6 weeks or less, the fifth most common patient complaint in both specialties, unless there are associated signs and symptoms suggestive of more serious disease.⁵ Studies have shown that early imaging of the lumbar spine provides no medical benefit but does increase healthcare costs. On the top 5 list for pediatric ophthalmology is to avoid routinely ordering neuroimaging studies for patients with double vision, because a complete eye examination will often identify the cause of double vision.¹⁴ The number of magnetic resonance imaging

examinations performed per capita in the United States in 2011 (102 per 1,000 population) was the highest among any country in the Organization for Economic Co-operation and Development.¹⁵ Given the high cost of neuroimaging studies, it would be helpful to identify other instances when neuroimaging studies could be eliminated without compromising the quality of patient care.

Determining whether an apparently swollen optic nerve represents pseudopapilledema or true optic disk edema is one area where ophthalmology can reduce healthcare costs. Because optic disk drusen frequently present as a swollen optic nerve head, differentiating it from life-and organ-threatening papilledema is essential. While there are certain ophthalmoscopic findings that can be helpful in differentiating between papilledema and pseudopapilledema—such as obscuration of the peripapillary retinal vessels, dilated capillaries and hyperemia on the disk surface, exudates for papilledema compared to a scalloped disk border, and absence of a physiological cup in an elevated disk and anomalous retinal vessels for pseudopapilledema—it is not always possible to distinguish between these conditions by ophthalmoscopy alone. Clinical suspicion of papilledema usually necessitates neuroimaging and lumbar puncture, both costly procedures. However, if the clinical suspicion of intracranial pathology is low, B-scan ultrasonography to evaluate for calcification of the optic disk as occurs with drusen is a reasonable, cost-effective screening test. Optic disk drusen are not always calcified in young children, so B-scan ultrasonography may not be helpful when negative. In these instances, other clinical findings will often guide the work-up.

OCT may prove to be a better diagnostic test for detecting optic disk drusen. Merchant and colleagues⁹ reported that enhanced depth imaging OCT was more effective in detecting optic disk drusen than B-scan ultrasonography in 68 adult eyes. Enhanced depth imaging OCT (EDI-OCT) also had the added advantage that it provided more detailed information regarding the structure of the drusen. Lee and colleagues¹⁰ performed spectral domain OCT on 99 eyes with optic disk drusen and reported that visible optic disk drusen were characterized by hyperreflective borders, consistent with calcification and associated with retinal nerve fiber layer thinning, whereas buried drusen were visible as cysts with varying degrees of internal homogeneity. Sato and colleagues¹² used both EDI-OCT and swept source OCT to evaluate adult eyes with optic disk drusen and reported that drusen were hyporefective and often bordered by hyperreflective curvilinear band. Most of the patients in our study did not have OCT performed because it is a relatively new diagnostic test; therefore, we could not compare the cost-effectiveness of OCT to B-scan ultrasonography. Fluorescein angiography can also be helpful in diagnosing optic disk drusen, and it can also be used to distinguish between optic disk drusen and optic disk edema. Surface optic disk drusen usually exhibit autofluorescence and nodular staining with fluorescein angiography; however, it is less helpful for diagnosing buried drusen. Pineles and Arnold¹³ classified 9 of 83 eyes with buried optic disk drusen as also having optic disk edema based on their fluorescein angiographic findings. However, after a further work-up, only 2 of these eyes were found to have true papilledema; the other 7 eyes had ischemic optic neuropathy, diabetic papillopathy, or no identifiable cause. Fluorescein angiography was not performed on most of the patients in our study because of the difficulty of performing fluorescein angiography in children. While fluorescein angiography offers the advantage of being able

to diagnose optic disk edema, it is less effective than ultrasonography, according to a study involving adults.⁸

This study was limited by its retrospective design. Also, certain clinical data was missing for some patients, and the medical records for some patients referred by outside doctors to the Emory Eye Center were not available for review. Such data would be useful in determining the rationale for the different evaluation pathways.

In conclusion, performing B-scan ultrasonography prior to neuroimaging is cost-effective and often eliminates the need for neuroimaging and lumbar puncture if the clinical picture does not suggest intracranial pathology.

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Fig 1. Right (A) and left (B) optic disk photographs of a 7-year-old boy presenting with optic disk swelling and occasional headaches.

Fig 2. Ophthalmic ultrasound of right (A) and left (B) eyes of the patient in Figure 1, confirming optic disc drusen. No further diagnostic testing was performed.

Table 1
Tests performed on patients with ultrasound confirmed optic disk drusen at Emory Eye Center

	Group 1 ophthalmic ultrasound prior to other studies	Group 2 ophthalmic ultrasound after other studies
Total number of patients	26	20
Patients receiving neuroimaging	3	20
MRI brain with and without contrast	0	9
MRI Brain without contrast	0	1
MRI brain and orbits with and without contrast	3	2
CT head (unknown contrast status)	0	2
CT head and orbits with and without contrast	0	1
CT head without contrast/MRI brain without contrast	0	1
MRI/MRV brain	0	1
MRI/MRA brain	0	1
CT Head (unknown contrast status) and MRI/MRA/MRV brain	0	1
Lumbar puncture prior to ophthalmic ultrasound	0	7
Asymptomatic patients who had imaging prior to ultrasound	0	8

CT, computed tomography; *MRA*, magnetic resonance angiography; *MRI*, magnetic resonance imaging; *MRV*, magnetic resonance venography.

Table 2
Cost in 2012 Georgia Medicaid dollars

Study/strategy	Cost
Ophthalmic ultrasound	\$84
MRI brain with and without contrast	\$952
MRI brain without contrast	\$447
MRI brain and orbits with and without contrast	\$1986
CT head and orbits with and without contrast	\$305
CT head without contrast/MRI brain without contrast	\$645
MRI/MRV brain with and without contrast	\$1014
MRI/MRA brain with and without contrast	\$1014
Lumbar puncture	\$107
Average cost of evaluations with ophthalmic ultrasound as first test ^a	\$305
Average cost of evaluations with ophthalmic ultrasound <i>not</i> as first test ^a	\$1173

CT, computed tomography; *MRA*, magnetic resonance angiography; *MRI*, magnetic resonance imaging.

^aPatients with neuroimaging not clearly specified (eg, unknown contrast status) were excluded from calculations