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Epidemiologist's View: Addressing the Epilepsy Surgery Treatment Gap with Minimally-invasive Techniques

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Abstract

Despite the fact that epilepsy surgery is both safe and effective, a considerable “surgical treatment gap” remains in that most persons who are eligible for surgery do not receive it. It has been argued that epilepsy surgery is one of the most underutilized of all accepted medical treatments in the world. In this article, we review the epidemiology of the epilepsy surgery treatment gap, and consider the role minimally-invasive epilepsy surgery may play in reducing this gap.

Keywords

Epilepsy surgery; minimally-invasive surgery; treatment gap; epidemiology; disparities; access to care

1. INTRODUCTION

1.1 Overview

Despite the fact that epilepsy surgery is both safe and effective, a considerable “surgical treatment gap” remains in that most persons who are eligible for surgery do not receive it. It has been argued that epilepsy surgery is one of the most underutilized of all accepted medical treatments in the world (Engel, 2014). In this article, we review the epidemiology of the epilepsy surgery treatment gap, and consider the role minimally-invasive epilepsy surgery may play in reducing this gap.

1.2 Minimally-invasive ablative epilepsy surgery

Minimally-invasive epilepsy surgery (MIES) procedures include stereotactic radiosurgery (SRS), stereotactic radiofrequency thermocoagulation (SRT), laser-induced thermal therapy

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(LITT), and MRI-guided focused ultrasound ablation (FUS) (Quigg and Harden, 2014). SRS is usually performed with a Gamma Knife and delivers tiny radiation beams to a single target in the brain. The other three are thermocoagulation methods that create a permanent lesion by applying high heat to the target area. As the name suggests, these procedures are less invasive than open surgery procedures like anterior temporal lobectomy (ATL). Because these procedures involve more precise ablations in a small area, recovery time and the risk of morbidities should be lower. Minimally-invasive techniques also provide the opportunity to perform ablation in a small area at a time to see how the patient reacts, and repeating the process as necessary, whereas repeat open surgery is generally not recommended (Quigg and Harden, 2014). Minimally-invasive procedures should cost less than open surgery per procedure (Quigg and Harden, 2014), but the initial capital investment in the required technology is higher. The evidence for effectiveness of MIES procedures is mostly based on observational studies, although there has been one clinical trial of SRS (Jehi and Jetté, 2016; Quigg and Harden, 2014). No clinical trial has compared any minimally-invasive procedure directly to an open surgery (Jehi and Jetté, 2016).

1.3 Epidemiology of epilepsy

Epilepsy accounts for 0.75% of the global burden of disease (World Health Organization, 2016). The worldwide point prevalence of active epilepsy is 6.38 (5.57–7.30) per thousand, or nearly 50 million people (Fiest et al., 2017). The incidence and prevalence rates are higher in low-income countries compared to high-income countries. The cost-of-illness ranges from 0.12 – 1.12% of national healthcare expenditures in high-income countries (Strzelczyk et al., 2008).

2. TREATMENT GAPS

2.1 Overall Treatment Gap

Before discussing the underutilization of epilepsy surgery, it is important to note that many people receive no epilepsy treatment at all. This “treatment gap” is defined as the percentage of the total number of people with active epilepsy that receive inadequate or no treatment (Kale, 2002). A systematic review estimated the treatment gap in resource-poor countries to be 56%, of which the main causes were: inadequate skilled manpower, cost of treatment, lack of availability of antiepileptic drugs, cultural beliefs, preference for traditional medicine, and distance to facilities (Mbuba et al., 2008). In high-income countries, the treatment gap is usually less than 10%, but can vary substantially within subpopulations (Meyer et al., 2010). The treatment gap makes it difficult to find many drug-refractory patients that would be candidates for surgery.

2.2 Surgical Treatment Gap

Approximately 20 – 30% of people with epilepsy are pharmacoresistant, and of these 10 – 50% may be eligible for surgery (Sridharan, 2002). Patients that fail to respond after two different first-line antiepileptic drugs are likely refractory and should be considered for surgery (Kwan and Brodie, 2000). Based on this estimate and the total prevalence, the number of possible epilepsy surgery candidates worldwide is between 1 million and 7.5 million people.

The treatment gap for surgery is higher than the treatment gap for pharmacotherapy, because surgery is so underutilized in both high-income and low-income countries (Meinardi et al., 2001). In the U.S., 3,000 – 4,000 surgeries are performed each year, but there are an estimated 100,000 to 200,000 surgical candidates, suggesting a surgical treatment gap of between 96% and 99% (Institute of Medicine (IOM), 2012).

The surgical treatment gap is large in high-income countries, even though many have the state-of-the-art equipment necessary to perform minimally-invasive and open epilepsy surgery, and most citizens have health care coverage. Much of this gap is due to underutilization and late referral. In the United States the average duration from onset to surgery for medically refractory is 20 years (Engel, 2014). The rate of surgery has not increased over time, despite the release of a practice parameter by the AAN recommending surgery for medically refractory temporal lobe epilepsy (Engel et al., 2003; Schiltz et al., 2013a). In Canada, less than 1.2% of patients with intractable epilepsy were referred to a center within two years of being defined as medically refractory (Burneo et al., 2016). In the United Kingdom, epidemiologic estimates also suggest a significant treatment gap in that the rate of surgery is only keeping pace with the rate of new cases, but not addressing the “back log” of prevalent cases (Lhatoo et al., 2003). Long term trends at one Germany epilepsy surgery center showed increases in presurgical evaluation, but no corresponding increase in surgery (Bien et al., 2013; Cloppenborg et al., 2016).

Within high-income countries, there are disparities in access to presurgical evaluation and epilepsy surgery by race, income, payer status, and geographic location (Burneo et al., 2016, 2009; Schiltz et al., 2013b). Barriers to surgery include lack of knowledge and misconception about epilepsy surgery, poor behaviors, cultural issues, access to care issues, and research gaps (Jetté et al., 2016). Misconceptions also occur at the physician level, where many favor non-surgical options and view surgery as a “last resort”, despite the fact that 12% of patients die within 2 years of being defined as intractable (Burneo et al., 2016; Jetté et al., 2016). MIES procedures have the potential to address some of these barriers, especially those related to fear and anxiety, as these procedures may be perceived as less risky. However, at this time evidence is not available to support this hypothesis.

2.3 Surgical Treatment Gap in Low-income Countries

The focus of this special issue is on the surgical treatment gap in high-income countries, but we will briefly mention issues experienced by low-income nations. There are many reasons for the surgical treatment gap in low-income countries, but perhaps the most obvious is that the health care systems in these countries have limited resources. Many of the poorest countries do not have any facilities with the equipment necessary for presurgical evaluation and epilepsy surgery (Radhakrishnan, 2009). Some low-income countries do have these facilities, but they are usually concentrated in the major cities, and may only be accessible to persons with high-income. Access to these services are out of reach for the majority of those living in rural areas and in poverty. Lack of human capital is also an issue in low-income countries, where there is an estimated one neurologist available for every 3 – 5 million people (Radhakrishnan, 2009). Governments lack the resources to invest in their entire medical system. Furthermore, epilepsy care is competing with HIV/AIDS, tuberculosis,

malaria, and other chronic illnesses for the limited pool of funds available. Cultural barriers, social stigmas, and preference for traditional medicine can also limit access to epilepsy surgery in developing countries. [Subsections describing Asia, Latin America, and Sub-Saharan Africa have been cut].

3. CHALLENGES AND OUTLOOK

It is clear the epilepsy surgical treatment gap is wide. The question is what needs to be done, and can minimally-invasive procedures help to close the gap?

Whether or not MIES can help close the surgical treatment gap depends on how effective these procedures are at curing epilepsy. As mentioned previously, there has not yet been a randomized controlled trial establishing the efficacy of any of these MIES techniques relative to the gold standard of resective surgery. It is also unclear if MIES procedures are less costly than open resective surgery. While minimally invasive procedures should provide cost savings in terms of operating time, recovery time, and costs of complications, these savings may be offset by the cost of equipment and the cost of training of neurosurgeons to perform MIES techniques. Some techniques like gamma knife require multiple sessions and follow-up and hence may have higher direct costs than standard resective surgery. More evidence is needed to establish both the cost and effectiveness of MIES, before MIES can be promoted as a solution to the surgical treatment gap.

If the efficacy of MIES is established, they could reduce the surgical treatment gap if these techniques are more palatable to patients. A key barrier to epilepsy surgery is patient and provider unwillingness to have surgery except as a last resort. However, patients may be more willing to undergo minimally-invasive procedures due to lower perceived risk. Again, studies are needed to establish if this is in fact the case.

Certain subpopulations have reduced access to epilepsy surgery, including racial and ethnic minorities, those without health insurance coverage, and those living in rural areas. It is not clear how MIES would reduce these disparities. Public insurance programs (e.g. Medicaid in the U.S.), which cover many low-income persons with epilepsy, are unlikely to cover procedures where efficacy is not proven. Curative resective surgery is cost-effective and could actually be cost-saving over continued AED treatment over the long-term (Picot et al., 2016; Schiltz et al., 2016). If MIES is also shown to be cost-effective, insurance coverage would likely increase. The equipment and personnel needed to perform MIES and presurgical evaluation are likely to be concentrated in large academic medical centers, which does not help access to care for those living in rural areas.

MIES techniques are unlikely to have much impact on closing the surgical treatment gap in low-income countries as these procedures are not readily available, and there are other challenges that need to be overcome to expand access to epilepsy surgery in these regions. Other approaches, including improving knowledge and attitude regarding epilepsy surgery in the community and among primary care physicians may be more effective in these countries (Rathore et al., 2014).

In conclusion, epilepsy surgery continues to be an underutilized procedure. Minimally-invasive procedures could help close the epilepsy surgery treatment gap in the long-run. However, more evidence is needed to establish the efficacy and effectiveness of MIES, and to quantify the direct and indirect costs of these procedures.

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HIGHLIGHTS

- Epilepsy surgery continues to be an underutilized procedure globally.
- Minimally-invasive procedures may have a lower perceived risk among patients and providers and hence could help close the surgical treatment gap.
- However, the efficacy and effectiveness of minimally-invasive epilepsy surgery relative to standard resective surgery needs to be established through controlled trials.