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Research Article

Cost Analysis of Telehealth for Management of Infantile Hemangioma in the United States

Ernesto Mejia[1], Manav Midha[2], Sonal Shah[1], Anand Kumar[1], Mark Votruba[2], Christopher S. Snyder[3]*

[1]Case Western Reserve University School of Medicine, Cleveland, Ohio, USA

[2]Case Western Reserve University Department of Economics, Cleveland, Ohio, USA

[3]Division Chief, Pediatric Cardiology Professor of Pediatrics, Virginia Commonwealth University, Richmond, Virginia, USA

***Corresponding author**: Christopher S. Snyder, Division Chief, Pediatric Cardiology Professor of Pediatrics, Virginia Commonwealth University 1000 E Broad St 5th floor, Room 344 Richmond, Virginia 23298, USA

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Abstract

Background: Hemangiomas are the most common soft-tissue tumors affecting neonates and rarely lead to complications. Objectives: Assess cost-effectiveness of managing infantile hemangiomas via Telehealth (TH) versus in-person (IP) visits. **Methods:** Patients with vascular anomalies were assumed to be in 1 of 3 states: infantile hemangioma, nonserious condition, or serious condition. Decision models were constructed for initial and long-term cost of care for patients with infantile hemangiomas. Management was defined as initial visit at 3 months of age with follow-up visits every 3 months until 15 months of age. Reimbursement values were extracted from Medicare data and economic estimates of indirect costs. The expected value of patient visits were calculated in the model, and the lower expected cost was considered optimal. Expected values were calculated under two perspectives: a patient/payer perspective and a "societal" (patient/payer/provider) perspective, the former assuming TH and IP visits would be equally reimbursed, and the latter incorporating the estimated cost saving arising from lower overhead costs. Deterministic sensitivity analysis was conducted to assess the most salient model inputs. **Results:** After accounting for increased risk of misdiagnosis and serious conditions, from a patient (payer) perspective, TH was associated with $10.26 cost savings for initial visit, and $51.30 through complete treatment course. From societal perspective TH saved $55.26 initially and $276.30 through complete course. Thus, in comparison to IP, TH is associated with 3.89% and 18.01% cost savings from the payer and societal perspectives, respectively. **Conclusion:** The use of TH for management infantile hemangioma proved to be cost effective.

Keywords: Pediatrics; Infants; Telemedicine; United States

Introduction

Infantile hemangiomas are the most common soft-tissue tumors diagnosed in infancy [1-3].These benign tumors affect 4-5% of all neonates with a female (2.3-2.9:1) predominance [2]. The incidence of infantile hemangiomas is even more prevalent in premature infants with a birth weight under 1000 grams reported in as high as 23%. [2]. In addition to their cosmetic disfigurement, complications require intervention have been reported from hemangiomas such as obstruction, ulceration, and bleeding, in up to 15% of patients [1, 4]. Infantile hemangiomas have been managed by a multitude of varying providers including: pediatricians, plastic surgeons, dermatologists, pediatric cardiologists, and pediatric hematology-oncologists. The options for treatment of these "benign" tumors over the years has been observation, steroid injections and surgical excision, none of which are ideal. To our knowledge, no studies have been performed on the potential for cost saving of telemedicine in the management of infantile hemangiomas.

Objectives

The purpose of this study was to assess the initial and long term cost-effectiveness of complete management of infantile hemangiomas via Telehealth (TH) compared to in-person (IP) visits.

Methods

A decision model was constructed in TreeAge Pro 2020 from both the patient and the societal perspective (TreeAge Software LLC, Williamstown, MA). The patient perspective incorporated both direct health care expenditures (corresponding to an out-of-pocket payer or insurer's perspective) and indirect costs—namely, transportation and lost labor productivity (corresponding to society's overall loss from inefficient delivery of care). IP visit costs were extrapolated using CPT billing codes for level 2 consult (CPT 99242) and level 2 follow-up (CPT 99232). The societal perspective expanded on this analysis by also including estimates of long-term cost savings from TH (savings from decreased administrative and utility burdens for health care providers, among others). Beginning with a decision of "Telehealth" versus "In person" visit for a potential hemangioma consultation (assuming a referral from a primary care provider), patients were placed into in one of three biological states: hemangioma, other ("nonserious") condition, or other ("serious") condition. If a given patient was in the "hemangioma" or "other serious condition" state, providers could either make the correct diagnosis, or miss the diagnosis (Figure 1).

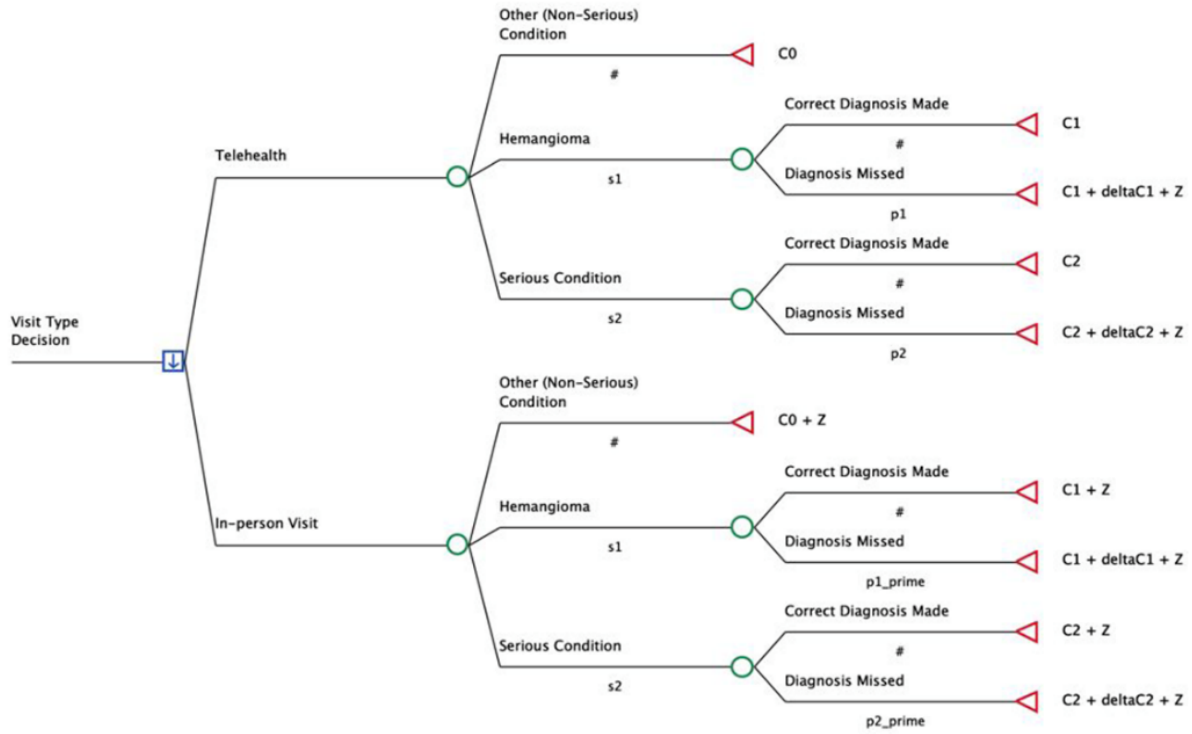

Figure 1: Decision tree shows health costs of TH *vs* IP. Decision tree is read from left to right. Hemangioma with correct diagnosis is cost C1, C1+delta C1 is cost of missed diagnosis. IP visit cost is C1 + Z for correct diagnosis.

We assumed patients choosing either visit type were balanced on all co-varying characteristics that those patients who chose TH versus IP visits were drawn from the same pool. Probabilities based on the extant literature and expert opinion were associated with each outcome. Importantly, 98% of referred patients were assumed to have hemangiomas and 1% each of the remaining patients were assumed to have serious and non-serious non-hemangioma conditions, respectively. In addition to these biological assumptions, the primary exogenous variable was the difference in diagnostic accuracy between IP and TH providers, which for hemangiomas were assumed to be 98% and 90%, respectively. One possible cause of this discrepancy is internet connectivity and/or screen resolution prohibiting accurate visualization of lesions during TH consultations. For severe non-hemangioma conditions, diagnostic accuracy was normalized to 100% for IP visits and set at 99% for TH. Payoffs were also associated with each outcome; values were extracted from the Medicare reimbursement schedule and economic estimates of indirect costs (travel and lost time) [5]. All patients received an initial visit, meaning this cost had no impact on decision-making; importantly, these results assume equal reimbursement for IP and TH visits. Based on a published cost-effectiveness analysis of hemangioma care, treatment was assumed to cost $138 [6]. If hemangioma diagnoses were missed, then regardless of initial visit modality, patients required follow-up IP visits ($72.19) and ultrasounds ($84.72), in addition to eventual propranolol treatment. Regarding costs of serious conditions, base expense was assumed to be $10,000; delay due to misdiagnosis was assumed to cost $5,000 more. All patients who received IP visits also faced costs of transportation and lost productivity (assuming one working parent brought their child to the appointment). These costs were $10.58 and $14.98, respectively, and followed average visit times to medical providers as seen in Medical Expenditure Panel Survey data and the standard assumption that individuals behave as if they value their own time at half their average hourly wage. The expected value of each visit modality was calculated in each model, and the modality with the lower expected cost was considered optimal. Complete management was defined as follow-up through 15 months of age. Initial visit assumed at 3 months of age with follow-up visits every 3 months. Percentage cost savings of TH versus an IP status quo were also calculated in each model when possible. A deterministic sensitivity analysis was conducted to assess the most salient model inputs.

Results

After accounting for increased risk of missed hemangioma and serious condition diagnoses, from a patient (payer) perspective, TH ($253.62) as an initial visit modality for infantile hemangiomas is associated with $10.26 in expected cost savings, as compared to IP initial visits ($263.88). This was equivalent to a $51.30 savings through complete treatment course. From a societal perspective (after accounting for long-term cost-savings from lower overhead costs in TH), TH as an initial visit modality is associated with $55.26 in cost savings and equivalent to $276.30 of savings through complete treatment course [7]. Thus, in comparison to IP standard-of-care, TH is associated with 3.89% and 18.01% cost savings from the patient/payer and societal perspectives, respectively. The infantile hemangioma disease burden in the United States is approximately 4.5% of all live births. In 2020, there were 3,613,647 total births in the United States in 2020, which account for approximately 162,614 infants affected by hemangiomas that year alone [8-9]. If half-to-all parents seek hemangioma care for their children, these results imply societal cost savings of $4.49 – $8.99 million annually from moving to TH as initial visit modality. Based on deterministic sensitivity analysis, the most salient model inputs for these estimates are the additional costs of IP visits (transportation and lost time) and the probability of missed hemangioma diagnoses in the IP setting.

Discussion

Infantile hemangiomas are classically managed conservatively as most involute spontaneously [1]. Indications for treatment include life-threatening hemangiomas, hemangiomas causing functional impairment, or those which may cause cosmetic disfigurement [1]. Modern medical management includes the use of beta-blockers such as propranolol [1-2]. In select cases, topical treatment with Timolol maleate has also been described with reasonable success [10]. Topical ultra-potent corticosteroids have been used, as well as intralesional triamcinolone injections with good results [11-12]. However, antimiotic agents such as bleomycin should be avoided in younger children and infants [1]. Another topical therapeutic option is the use of imiquimod. Imiquimod is a topical antiangiogenic agent which has shown moderate effectiveness against superficial infantile hemangiomas [13]. Though many treatment options exist, infantile hemangiomas have been previously managed my multidisciplinary teams with IP office visits. There is no data available on the cost-effectiveness of using TH as a viable surveillance modality for this subset of patients. TH has been defined as the "specific application of technology to conduct clinical medicine at a distance and establishment of a connection between physicians and patients in a multitude of settings" [14]. With the start of the COVID-19 pandemic, there was a substantial increase in the use of TH in the medical field [15]. During this time, many institutions were able to establish basic TH infrastructure with different policies and procedures to be followed [15]. This included the ability to obtain informed consent for the TH visit, maintaining HIPAA compliance, and acknowledging the limitations of a TH consultation compared to an IP visit [15]. Though limitations exist, in our study population, TH consultation and follow-up has proven to be both efficient and cost-effective. Unlike other pathologies, most infantile

hemangiomas can be followed serially by visual inspection to assess therapeutic effectiveness. This can be done by a physical exam, pictures provided by the family, or a video TH appointment. When considering the strain of the current medical system with the on-going pandemic, our results proved both an efficient and economic advantage to managing infantile hemangiomas.

Conclusion

The use of TH for initial hemangioma consultation through complete management course proved to be cost-effective from both a payer/patient and societal perspective compared to IP office visits. These models suggest TH is a viable management strategy for the complete treatment course of this disease. Expanding this model to all children with hemangiomas may result in substantial total cost savings in the care of these patients.

Conflict of Interests

The authors have no conflicts of interest relevant to this article to disclose

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