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Economic Outcomes of the Addition of Fluoroscopic Guidance to the Lumbar Puncture Procedure: A Call for Standardized Training

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Abstract

Objectives:

1. To evaluate the socio-economic impact of the addition of fluoroscopic guidance to the lumbar puncture procedure through our institutional series from 2010 to 2013.
2. To investigate the increased cost and socio-economic impact associated with fluoroscopic guidance, which at our institution is used after failure of blind procedure.
3. To describe the utility of standardized training to decrease the number of failed bedside lumbar

Patients and methods: A retrospective analysis of 211 lumbar punctures from LSU Health Sciences in Shreveport, LA was analyzed under the current neuroendovascular faculty (2010-2013) via use of billing data. Results were restricted to lumbar punctures performed for diagnostic (CPT 62270) or therapeutic codes (62272) with the addition of fluoroscopic guided placement of needle (77003). Neurosurgical resident lumbar punctures are not billed for by the department and therefore are not accounted for in analysis.

Results: 88 lumbar punctures performed were diagnostic and 123 were billed as therapeutic. 93 cases were done with addition of fluoroscopic guidance either directly from neurosurgical resident blind procedure failure or consulting service blind procedure failure. 70 patients were free care with no charge. The department billed $80,469 and collected $13,004 for the actual lumbar puncture procedure (62270 and 62272). The average additional billing cost for fluoroscopic guidance was $356. However, of the additional $41,649 billed only $2014 was collected. For the additional use of fluoroscopy, the mode for Medicaid re-imbursement was $19 and for Medicare was $41. This does not take into account the additional use of radiology technologists, procedural nursing, and recovery nursing.

Conclusion: This study is limited by information available for retrospective review. Fluoroscopic guided lumbar punctures utilize skills and procedural time of the neuro-interventionalist. Focused standardized training of residents, which has been proven to improve lumbar puncture success outcomes, would reduce the use of these valuable resources.

Keywords: Fluoroscopy; Lumbar puncture; Neuro-interventional procedures

Introduction

In the USA alone, it is estimated that 400,000 diagnostic lumbar punctures are performed annually [1]. The average U.S. price of the lumbar puncture procedure itself is $364, which equates to an annual $146 million in billings, not including the use of fluoroscopy [2]. Advent of technology has seen the integration of fluoroscopic guidance increase the accuracy of this historically developed procedure.

The lumbar puncture has been in clinical use for over a century. It began with Henrich Quincke during 1842-1922 and his use of a hollow needle to breach the subarachnoid space at L3-L4 level versus Walter Essex Wynter's during 1860-1945, incision at L2 with insertion of a cannula and trocar through dura mater [3]. Both of the physicians developed the technique as a therapeutic tool to remove cerebrospinal fluid (CSF) in patients with hydrocephalus and tuberculous meningitis. Studies of CSF itself date back to the Egyptians description of the meninges in 1500 BC and the well-known "water in the head" described by Hippocrates in ancient Greece [4]. For centuries, the knowledge of CSF has superseded the ability to turn it into something of therapeutic or diagnostic value. Today the use of lumbar puncture plays a pivotal role in the diagnosis of bacterial, fungal, mycobacterial, and viral CNS infections and in certain settings, demyelinating diseases [5].

Historically, the lumbar puncture is a bedside procedure and success has been directly related to the competence of the physician performing the procedure [6,7]. With the arrival of technology, the lumbar puncture has been guided by concurrent development of biplanar fluoroscopy, which is used in our institution for cases that failed blind procedure. This comes at cost related to the addition of fluoroscopy including technology, procedure room time, nursing care, radiology technologist care, and neuro-interventionalist procedural time. Our goal is to investigate the increased socio-economic impact associated with fluoroscopic guidance, which at our institution is used after failure of blind procedure.

Patients and Methods

Procedure

A line drawn from the superior iliac crest bilaterally can help determine the approximate position of the 4th lumbar vertebrae. The patient is instructed to lie in the "fetal position" with the knees pulled up towards the abdomen and neck flexed towards the chest while

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maintaining the shoulders and hips in a vertical plane [5,8]. Typically, the intended puncture site is cleaned with alcohol and a disinfectant followed by a local anesthetic, such as 3-5 mL of 1% lidocaine into the subcutaneous tissue [8]. A 20- to 22-gauge needle is inserted midway between the spinal processes with the bevel of the needle horizontal with the patient's spine, generally at the L4-5 level [8]. Once the subarachnoid space is punctured the physician typically attaches a manometer to the needle and the opening pressure is measured. Varying amounts of CSF are collected into test tubes depending on the tests indicating the lumbar puncture; it is estimated that 40 mL of CSF could be safely removed from an adult.8 After two failed attempts (junior and subsequent senior resident) to effectively ascertain CSF from the subarachnoid space current neurosurgery service hospital protocol states that the patient must be taken to a neuroradiology suite where fluoroscopic guidance is used to view the procedure in real time.

The typical fluoroscopically guided lumbar puncture is done in the prone or lateral decubitus position on a radiographic table. The physician may view the entry of the needle as it passes between the spinous processes entering in the appropriate level in the proper anterior-posterior and lateral directions. Information feedback is in real time.

Economic analysis

A retrospective analysis of 211 lumbar punctures from LSU Health Sciences in Shreveport, LA was analyzed under the current neuroendovascular faculty (2010-2013) via use of billing data. Results were restricted to lumbar punctures performed for diagnostic (CPT 62270) or therapeutic codes (62272) with the addition of fluoroscopic guided placement of needle (77003). Neurosurgical resident lumbar punctures performed in the intensive care unit or floor are not billed for by the department and therefore are not accounted for in analysis.

Results

Over are period of three years, there were 88 lumbar punctures billed as diagnostic and 123 billed as therapeutic. Of the 211 lumbar punctures performed, 93 cases were done with addition of fluoroscopic guidance either directly due to neurosurgical resident blind procedure failure or consulting service blind procedure failure. Fluoroscopy was used in 44.1% of all cases. The department billed $80,469 and collected $13,004 for the actual lumbar puncture procedure (62270 and 62272). The average additional reimbursement received for fluoroscopic guidance was $356. However, of the additional $41,649 billed only $2014 was able to be collected (Figure 1). This is a capture rate of only 4.8%. For the additional use of fluoroscopy, the average Medicaid re-imbursement was an additional $19 and for Medicare it was $41. There were 70 patients that were free care with no applicable charges.

Discussion

Cost

As stated above, LSU Health Sciences Neurosurgery Department charged $80,469 for lumbar puncture yet only $13,004 was collected. The addition of fluoroscopy accounts for $41,649 billed of which only $2014 was collected. At our institution, fluoroscopic guidance is an adjunct technology to the basic lumbar puncture procedure once the physician has failed to penetrate the subarachnoid space. The reimbursement data does not take into account the additional use of radiology technologists, procedural nursing, and recovery nursing.

Use of the radiographic suite for routine procedures is not cost effective. Craig showed in trauma patients that using ultrasound guided insertion of vena cava filters drastically reduced costs [9]. Over a 13-month period costs were reduced by $69,800 in comparison with the typical use of the interventional suite and $118,300 in comparison with operative placement. In the management of chronic pain Barry argued via minimization analysis that epidural injections using fluoroscopy may not be justified by current literature [10].

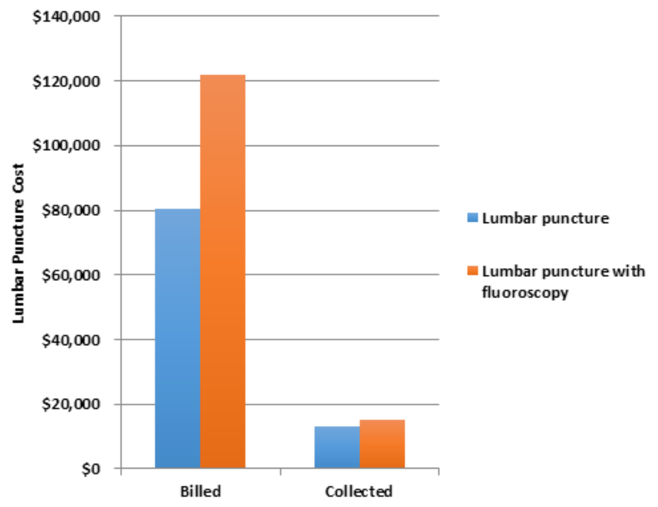

Figure 1: A Comparison of lumbar puncture and lumbar puncture with fluoroscopy reimbursement.

From a policy perspective, this drives up overall healthcare costs to society and increases utilization of resources. Controversially, from an economist's standpoint this may or not represent an economic failure or an economic success to the hospital system. Economists make decisions at the margin. That is the marginal benefit of performing one additional procedure. Economists also make decisions regarding opportunity cost. Each action performed comes at the cost of another opportunity. Each decision made is compared directly to the next possible alternative that is subsequently missed. If a lumbar puncture is performed in the fluoroscopic suite during an idle time-period during regular business hours, then the marginal benefit is superb in that resources are already allocated to performing a procedure of any type. There is great benefit to using the available resource infrastructure. If a lumbar puncture is performed during the evening hours the marginal benefit is more mild in that a procedure with low reimbursement requires more recourses (overtime pay, additional staff, etc..). Should the lumbar puncture be performed during the day in the place of a high income generating procedure the marginal benefit is disastrous in that there was a missed opportunity for a higher income.

Incentives also matter to economists. Currently, incentives favor volume with reimbursement largely and almost solely related to volume of services provided. However, as sweeping cost reduction and containment increases in the future emphasis will be on a quality rubric. An increase in simulation-based training will improve outcomes in lumbar punctures thereby reducing the utilization of resources.

Lumbar puncture outcomes

Complications and failure rates are a result of practioner training. An CJE reported that the frequency of traumatic lumbar puncture at bedside occurred 14% of the time whereas fluoroscopy guided lumbar puncture only had an incidence of trauma occurring 6.6% of the time. In both cases the failed or traumatic lumbar puncture occurred due to faulty technique [6]. The study showed that skill and technique played an important role in determining the outcome of the procedure versus the experience of the physician. Even with fluoroscopic guidance the rate of traumatic spinal tap ranged from 0-24% between individual physicians.

Edwards reported that neurology resident PGY3's performed 76% of the lumbar punctures with an 82.3% success rate and post-residency success rates decreased to 68.4% yet they only performed 5% of the lumbar puncture procedures, post-residency [10]. Resident competence in the procedure seemed to peak between PGY1-3 yet faltered during post-residency. Most training of these basic and universal procedures occurs in the first several years of any residency program. Currently, at our institution, there are no standardized simulation criteria.

The focus of procedural success is on technique. Furness studied the accuracy of ultrasound imaging to identify a lumbar interval accurately compared to basic palpation [11]. Their data revealed that correct identification of lumbar levels via palpation was only accurate in 30% of the cases whereas the use of ultrasonography correctly identified a specific spinal level in 71% of cases.11 Having a thorough and complete knowledge of the working and specific anatomy is paramount in completing a successful lumbar puncture using anatomical structures as guidelines [12]. Boon argued that with adequate prior skills practice and a complete understanding of regional anatomy along with rationale of the technique that the blind lumbar puncture can be carried out safely and successfully [12]. Stitz predicted the success of lumbar puncture using palpable landmarks and checked accuracy of placement using fluoroscopy [13]. The author had a first-attempt success rate of 74.1% and improved to 87.5% upon successful identification of anatomical landmarks. This further advocates for proper training of residents to identify and understand both anatomical landmarks and variation along with teaching a more solid skill foundation.

Simulation Based Training (SBT)

Simulation based training can greatly aid in that process. Medical simulation training truly started in the early 1960s with Resusci-Anne due to prompting from Dr. Peter Safar, an anesthesiologist. Resusci-Anne was initially created to practice mouth to mouth resuscitation, but was later modified to include a spring in the chest cavity to practice cardiopulmonary resuscitation (CPR) [14] As technology has advanced a mere 50 years the procedural and academic simulation training has garnered increasingly acceptance and is beginning to find a place in hospital settings [14].

The first logical step in teaching residents how to properly perform lumbar puncture as only one of many procedures learned is to turn to simulation training. Over the past years there has been a heightened emphasis on the safety and quality of patient care rather than bedside teaching and hands-on education [15]. This shift in the medical curriculum has left many students feeling unprepared when summoned to apply their textual learning in a clinical scenario [16]. Okuda explains that there is a gap between classroom and clinical environment and proposes that the solution to bridge this divide lies in simulation training [15].

The Accreditation Council for Graduate Medical Education Requirements for Graduate Medical Education (GME) in General Surgery mandates that "... resources [of a program] must include simulation and skills laboratories. These facilities must address acquisition and maintenance of skills with a competency-based method of evaluation [17]. Derossis tested laparoscopic skills among residents using a simulator to grade performance and improvement [18]. Results showed that skill and performance improves substantially with practice and repetition [18]. Goova study evaluated the feasibility and results of implementing a proficiency-based knot-tying and suturing curriculum [19]. Over a period of 12 weeks' residents was expected to follow specific guidelines and then were tested on the skills learned. Pretest and posttest scores validated skill acquisition with the conclusion that proficiency-based curriculum over an extended repetitious period rather than learning en-masse proves to be effective [19].

SBT cost effectiveness

The most progressive simulation training, combining learning multiple learning modalities have been found to be the most cost-effective compared with that of virtual reality and mannequin use individually [20]. In an actual surgical setting in complex cranio-maxillofacial (CMF) surgery the computer aided surgical simulation (CASS) system has been shown to decrease both time in preparation and cost of the overall surgery per patient; all which is accomplished through simulation [21]. The cost of simulation training may be hard to determine per particular training program but it is hard to argue that costs of simulation training would be more than offset by increased efficiency and decrease in procedural errors [22]. It can be extrapolated that decreased complications rates and litigation effects would be paramount. Cohen reported that catheter-related bloodstream infections (CRBSI) were costing the hospital on average $82,730 [23]. After simulation training 9.95 CRBSI's were prevented saving the hospital on average $704,034 to $711,248, after the maintenance cost of the training [23].

According to a survey conducted by the Association of American Medical Colleges, 69% of respondents in medical school settings used simulators to practice lumbar punctures, whereas teaching hospitals only used simulators for lumbar puncture practice 44% of the time. Passiment reported that General Surgery residents used simulators for training between 89-91% of the time during the first three years of residency [24]. The addition of this reasonably ubiquitous technology to a fairly ubiquitous procedure would greatly aide patient safety, protect resources, affect cost, and increase the value of care provided.

Limitations

The study is limited by information available for retrospective review. The study assumes a degree of generalization among patients in both billing and collection terms along with the circumstances and details of the lumbar puncture procedure itself. The study also lacks randomization and a control.

Conclusion

Fluoroscopic guided lumbar punctures utilize skills and procedural time of the neuro-interventionalist. Focused standardized training of residents, which has been proven to increase lumbar puncture success outcomes, would reduce the use of these valuable resources. As shown above, SBT training should be a core focus in the development of procedural skills and lumbar puncture is no exception. Adequate preparation and continual practice throughout residency is key in retaining a high lumbar puncture success rate. This study proposes that the increased use of SBT will reduce the costs associated with failed lumbar punctures and the subsequent use of fluoroscopy.

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