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Antimicrobial Prophylaxis at the Neurosurgical Department of a Major Hospital in China: Compare of Cross-Sectional Studies

Çin'de Büyük Bir Hastanede Nöroşirürji Bölümünde Antimikrobiyal Profilaksi: Çapraz Kesit Çalışmalarının Karşılaştırılması

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ABSTRACT

AIM: To compare the effects of post neurosurgical antimicrobial prophylaxis before and after the adoption of a new protocol in our department, which changed from prolonged prophylaxis to limited usage.

MATERIAL and METHODS: Two cross-sectional studies were performed to compare the 24-hour antimicrobial use for all the inpatients at the neurosurgical ward 1 day before (June 30, 2011) and 1 year after (June 29, 2012) the beginning of the new rules. Student's t-test or the chi-square test were used to compare baseline characteristics and prophylactic or therapeutic antimicrobial usage between the groups.

RESULTS: The total of 391 patients enrolled consisted of 221 for June 30, 2011 as group 1 and 170 for June 29, 2012 as group 2. The baseline characteristics of the groups showed no significant difference. The prophylactic use significantly decreased in Group 2 (13.1% vs. 5.9%, p=0.018). However, total therapeutic use (10.9% vs. 18.2%, p=0.041) and the use for nosocomial infection (7.32% vs. 15.9%, p=0.009) both increased significantly in Group 2. Furthermore, therapeutic use for surgical site infections also increased significantly (3.16% vs. 9.41%, p=0.015).

CONCLUSION: Shorter antimicrobial prophylaxis may increase post neurosurgical infection. The optimal duration of neurosurgical antimicrobial prophylaxis should be compliant with local hospital conditions and further prospective trials are required to address this issue on a procedure-specific basis.

KEYWORDS: Antimicrobial prophylaxis, Neurosurgery, Cross-sectional study

ÖZ

AMAÇ: Uzun süreli profilaksiden kısıtlı kullanıma geçecek şekilde bölümümüzde yeni bir protokolün kabullenilmesinden önce ve sonra nöroşirürji sonrasında antimikrobiyal profilaksinin etkilerini karşılaştırmak.

YÖNTEM ve GEREÇLER: Nöroşirürji bölümünde yeni kuralların başlamasından bir gün önce (30 Haziran 2011) ve 1 yıl sonra (29 Haziran 2012) tüm hastalarda 24 saat antimikrobiyal kullanımını karşılaştırmak üzere iki çapraz kesit çalışma yapıldı. İki grup arasında başlangıç özelliklerini ve profilaktik veya terapötik antimikrobiyal kullanımını karşılaştırmak üzere Student t testi veya ki-kare testi kullanıldı.

BULGULAR: Çalışmaya toplam 391 hasta alındı ve bunlardan 221'i 30 Haziran 2011 için grup 1 olarak ve 170'i 29 Haziran 2012 için grup 2 olarak kaydedildi. Grupların başlangıç özellikleri önemli farklılık göstermedi. Profilaktik kullanım Grup 2'de önemli ölçüde azaldı (%13,1 ve %5,9, p=0,018). Ancak nozokomiyal enfeksiyon için kullanım (%7,32 ve %15,9, p=0,009) ve total terapötik kullanım (%10,9 ve %18,2, p=0,041) değerlerinin her ikisi Grup 2'de önemli ölçüde arttı. Ayrıca, cerrahi bölge enfeksiyonları için terapötik kullanım da önemli ölçüde arttı (%3,16 ve %9,41, p=0,015).

SONUÇ: Daha kısa antimikrobiyal profilaksi nöroşirürji sonrası enfeksiyonu artırabilir. Nöroşirürji için antimikrobiyal profilaksinin optimum süresi yerel hastane koşullarına uymalıdır ve bu konuyu spesifik bir temelde ele almak için ek prospektif çalışmalar gereklidir.

ANAHTAR SÖZCÜKLER: Antimikrobiyel profilaksi, Nöroşirürji, Çapraz kesit çalışması

INTRODUCTION

Surgical Site Infections (SSI) are the most common complication following surgery, with reported rates ranging from 5% to 30% (20). Proper use of antimicrobial prophylaxis could control the rate of surgical site infections and reduce the potential nosocomial infection rate (1). In the neurosurgical field, the proper way to administer antimicrobial prophylaxis is still controversial, especially regarding procedures involving postoperative communication of the Cerebral Spinal Fluid (CSF) and the environment, such as the use of an invasive Intra Cranial Pressure (ICP) monitoring device, and External Ventricular Drainage (EVD) or other intracranial drainages, as there is a lack of data evaluating the continuation of EVD with and without antimicrobial prophylaxis.

Meanwhile, the implementation the Management Rules of Antimicrobial Usage by the Chinese Ministry of Health in July 1, 2011, provide us a unique opportunity to observe the effects of reduced antimicrobial prophylaxis use for all

non-emergency neurosurgery with or without postsurgical drainage. The rules specified that antimicrobial prophylaxis in all surgical departments should only be used within 30 min to 2 hours before surgery and no more than 24 hours after surgery. Before the rules, antimicrobial prophylaxis in our department was usually prolonged to 3 to 6 days, especially when an intracranial drainage system was implanted.

MATERIAL and METHODS

Study Design

Two cross-sectional studies were performed to identify and compare the 24-hour antimicrobial use for all the inpatients at the neurosurgical ward 1 day before (June 30, 2011) and 1 year after (June 29, 2012) the beginning date of the implementation of the rules.

Study Patients

A total of 391 patients were included in our study: 221 patients who were in the wards during the 24 hours of June 30, 2011 were assigned as group 1, while 170 patients in the 24 hours of June 29, 2012 were assigned as group 2. The patients in the neurological intensive care unit were not included in our analysis.

The charts of the included patients were carefully reviewed. Infections were diagnosed by clinical symptoms, laboratory or other diagnostic test such as blood, CSF or phlegm exam and culture. Nosocomial infections and SSI were identified following the Center for Disease Control definitions (8), and postsurgical meningitis and ventriculitis were included as SSI. Antimicrobial use was classified as therapeutic if the patient was diagnosed with infection, and prophylactic otherwise.

Antimicrobial Prophylaxis Strategies

Before the rules were implemented on July 1, 2011, the antimicrobial prophylaxis strategy in our department for all neurological surgery (surgery type shown in Table I) included (i) use of cefathiamidine, a first generation cefalosporin, for most patients, and Clindamycin for those patients allergic to cefathiamidine, (ii) a single dose of antibiotics administered 30 min to 2 hours before the skin incision, (iii) an additional dose given during surgery if the operation continued more than 3 hours or major blood loss occurred, (iv) postoperative prophylaxis for 3 days or until the drainage was removed (usually 3 to 6 days).

After July 1, 2011, we did everything else the same, except that the postoperative prophylaxis was discontinued within 24 hours after surgery. The main surgical team including the surgeons, anesthetists and nurses was also the same.

Statistical Analysis

Data were analyzed using PASW Statistics 18.0. Student's t-test was used to identify age difference between the groups, and the chi-square test was applied for the other factors. Probability values of less than 0.05 were considered to indicate statistical significance for all tests.

Table I: Patients' Baseline Characteristics

	Group 1 n=221, (%)		Group 2 n=170, (%)		p value
Age					
Years, mean (SD)	44.6	(18.4)	41.6	(21.2)	0.134
Gender					0.403
Male	139	(62.9)	99	(58.2)	
Female	82	(37.1)	71	(41.8)	
Neurosurgical abnormality					0.386
Intracranial tumor	111	(50.2)	71	(41.8)	
Cerebral vascular disease	47	(21.3)	40	(23.5)	
Spinal lesion	15	(6.8)	16	(9.4)	
Functional abnormality	9	(4.1)	12	(7.1)	
Trauma	39	(17.6)	31	(18.2)	
Surgical characteristics					
With intracranial drainage[a]	57	(25.8)	40	(23.5)	0.638
VP shunt surgery	4	(1.8)	2	(1.2)	0.701
Comorbidities					
Diabetes	7	(3.2)	4	(2.4)	0.763
Systemic malignancy	10	(4.5)	5	(2.9)	0.597

[a]*Include all devices which may communicate the cerebral spinal fluid to environment, such as external ventricular drainage, subdural or intra residual cavity drainage and intra cranial pressure monitor.*

RESULTS

Baseline Data

In total, 391 patients were included in the study, consisting of 221 patients for the day of June 30, 2011 as group 1, and 170 patients for the day of June 29, 2012 as group 2. The age, gender, types of neurosurgical abnormality, surgical characteristics and comorbidities that may increase the risk for SSI were listed and compared in Table I. No statistical difference was identified between the groups.

Diagnostic Evidence for Infections

All patients diagnosed as infections are with fever or blood count changes. For the 16 nosocomial infections in group 1, 7 of them have nucleated cells elevation in CSF, 3 of them got positive CSF culture results and 9 of them had positive sputum cultures. For the 27 nosocomial infections in group 2, 9 of them had nucleated cells elevation in CSF, 2 of them got positive CSF cultures, 5 of them had positive sputum cultures, 3 of them got positive chest Computer Tomography (CT) scans and 1 of them got positive urine culture.

Antimicrobial Usage

Total antimicrobial usage and subtypes of prophylactic and therapeutic antimicrobial usage are listed in Table II. Total antimicrobial usage showed no significant difference (24.0% vs. 24.1%). Prophylactic use significantly decreased in Group 2 (13.1% vs. 5.9%, p=0.018), and so did the rate of prolonged prophylactic use after surgery (5.0% vs. 0.6%, p=0.015). On the other hand, therapeutic use significantly increased in Group 2 (10.9% vs. 18.2%, p=0.041), and the use for nosocomial infection also raised in Group 2 (7.32% vs. 15.9%, p=0.009). Furthermore, as regards nosocomial infections, therapeutic use for SSI was elevated significantly (3.16% vs. 9.41%, p=0.015) and no statistically significant difference was found in the rates of other types of nosocomial infections.

DISCUSSION

The ideal antimicrobial prophylaxis for SSI prevention would lead to adequate concentrations at the incision site during the period of potential contamination with the shortest effective dose to minimize adverse effects, development of resistance, and cost (9). This would indicates that the surgical area has already been infiltrated and protected by the antimicrobial agent before the incision is made. The timing for admission medication should therefore be within a short period before the incision. Both animal studies and clinical trials support this theory (4, 6). A consensus has been reached through variable guidelines worldwide that surgical antimicrobial prophylaxis should be administered 30 min to 2 hours before the skin incision (3, 7). We have applied this timing protocol for years and it did not vary before and after the implementation of the rules.

Secondly, antimicrobial prophylaxis requires maintaining an effective drug concentration during the potential contamination period. Lack of necessary prophylactic redosing has been reported as a significant risk factor for SSI in various surgical fields (19, 25), while continuing prophylaxis for more than 24 hours postoperatively was found to be of no additional protective benefit (10, 17, 18). Some studies showed prolonged antibiotic prophylaxis was correlated with an increased risk of acquired antibiotic resistance (10, 11). Many guidelines therefore recommend discontinuing prophylaxis within 24 hours after the surgery (3, 15, 21).

Our study found that although prophylactic use significantly decreased after the adoption of the rules, possibly directly related to the reduction of prolonged use after surgery, the total antimicrobial usage did not show any difference. The therapeutic use was significantly increased and was the main contributor to the increased use for SSI, while the use for non-nosocomial infections and other types of nosocomial infections did not differ significantly. Before the rules, our rate of SSI (3.16%) was comparable to those

Table II: Comparison of Antimicrobial Usage

	Group 1 n=221, (%)		Group 2 n=170, (%)		p value
Total antimicrobial usage	53	(24.0)	41	(24.1)	0.975
Prophylactic	29	(13.1)	10	(5.9)	0.018
Use for none emergency surgery[a]	15	(6.8)	8	(4.7)	0.516
Prolonged use after surgeries	11	(5.0)	1	(0.6)	0.015
Use for open trauma	3	(1.4)	1	(0.6)	0.636
Therapeutic	24	(10.9)	24	(10.9)	0.041
Use for nosocomial infections	16	(7.23)	16	(7.23)	0.009
Surgical site infections	7	(3.16)	7	(3.16)	0.015
Lung infections and others	9	(4.07)	9	(4.07)	0.356
Use for non-nosocomial infections	8	(3.6)	8	(3.6)	0.564

[a] *Include all devices which may communicate the cerebral spinal fluid to environment, such as external ventricular drainage, subdural or intra residual cavity drainage and intra cranial pressure monitor.*

reported in the literature (approximately 0.15% to 7.7%) (2, 12, 23). Currently, we have a high rate of SSI (9.41%), when antimicrobial prophylaxis was discontinued within 24 hours after all clean neurosurgical procedures without taking into account whether EVD or other intracranial drainage systems were placed.

Our results are quite different from the current trend of practice, as most guidelines suggest shortening the postsurgical antimicrobial prophylaxis use. There might be two reasons contributing to this difference. The primary reason is that the majority of these guidelines focus on operations that are less controversial regarding antimicrobial prophylaxis or have more published evidence to support the suggestions, such as gastrointestinal, orthopedic, gynecological and cardiovascular surgery. Neurosurgery is usually not the focus. Even for the guidelines with recommendations for neurosurgery (1), the appropriate prophylaxis duration could not be specified for several special procedures such as transsphenoid sinus surgeries, ventricular peritoneal (VP) shunt surgeries, invasive ICP monitoring surgeries, and other intracranial drainage surgeries as there is lack of any evidence to support suggestions.

On the other hand, these procedures play a pivotal role in observing or maintaining intracranial pressure. We must sometimes leave the devices in place for varying lengths of time, ranging from 48 hours to 7 days. It is possible for pathogens to migrate through these devices that provide communication between the CSF and the environment postoperatively. What we do know from the current literature is that postsurgical drainage and ICP monitoring are related to a higher risk of SSI (13, 14). However, the efficacy of the antimicrobial prophylaxis, which regimen to use and the duration to use are still controversial (2, 22, 24). In a recent international survey of neurosurgeons, and critical care medicine and infectious disease specialists, 56.3% of neurosurgeons used prophylaxis as long as the EVD was in place, while only 11.5% of infectious disease specialists were in favor of doing so (16).

Furthermore, neurosurgery is not the only field with this kind of controversy. In prosthetic breast reconstruction surgery, there have been reports of increased postoperative SSI when the authors changed their practice from continuing perioperative prophylactic antibiotics for a prolonged time or until the drains are removed to giving no prophylaxis postoperatively (5).

The second reason for our results to differ from current guidelines might be the hospital condition differences. Most of the guidelines were composed based on studies conducted in North American or European countries, where neurosurgical patients usually have separated room with qualified nursing staffs. However, the hospitals are often overcrowded with less service staffs in many developing countries. These hospital conditions due to the socioeconomic difference may increase the risk of postsurgical infection for the patients. Although our institute is the leading health center in the west of China, we are unable to provide single rooms for all the neurosurgical patients. In most cases, a postsurgical patient has to share a room with 3 to 6 other patients. The family members also have to stay and take care of the patient as the nurses are often understaffed. In this condition, postoperative prophylactic antibiotics may be justified because the patients are in a vulnerable environment and the potential consequences of post neurosurgical infection are severe. The optimal duration of neurosurgical antimicrobial prophylaxis may therefore need to be compliant with local hospital conditions, which may vary due to the local socioeconomic environment.

The limitation of this study is that it is cross-sectional. Although all the inpatients of the neurosurgery department were enrolled in the analysis at the two designed time periods, we could not prospectively control the two groups. However, we tried to eliminate the bias arising from the baseline data of the groups. The times we chose to perform the study were both in the summer, at the end of June, as we tried to control the bias caused by seasonal variation, because the incidence of some neurosurgical conditions such as hemorrhagic stroke are influenced by season changes and geriatric patients tend to have more pneumonia in the winter time. All these may potentially affect the infection rate. We also tested the age, gender, type of neurosurgical condition and postsurgical drainage, as well as the comorbidities, which may influence risk of infection of the groups. The result showed that the groups were comparable as no significant difference was found. Although the cross-sectional nature could not allow more detailed analyses, we do provide a picture about what will happen if common prophylaxis rules are extensively applied to the unconfirmed procedures in a different socioeconomic environment.

CONCLUSION

Shorter antimicrobial prophylaxis may increase post neurosurgical infection. Different procedures have their own characteristics, and we cannot apply the same antimicrobial prophylaxis protocol to all neurosurgeries. The optimal duration of neurosurgical antimicrobial prophylaxis should be compliant with local hospital conditions and further prospective trials are required to address this issue on a procedure-specific basis.

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