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PERSPECTIVE

Challenges in Initiating a Cerebral Aneurysm Coiling Programme in a Small Centre: Our Experience after the First 100 Cases

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ABSTRACT

After completing the 100th intracranial aneurysm coiling at our site in 2017, we reflect on the challenges of implementing a new neurointerventional radiology programme in a small tertiary care centre. Our radiology group is the sole provider of cerebral coiling for a population of approximately 500,000, first offering this procedure in March 2013. Given the challenges that we encountered while establishing this programme, we wish to share lessons learned about resource advocacy, early involvement of key stakeholders, and timely programme introduction to help others facing similar needs.

Key Words: *Aneurysm, ruptured; Embolization, therapeutic; Intracranial aneurysm; Radiology*

中文摘要

在小型醫療中心開始腦動脈彈簧圈栓塞術面臨的挑戰：最初100例後我們的經驗

C Woodworth、V Linehan、N Hache、R Bhatia、P Bartlett

2017年在我們的醫院完成第100例顱內動脈瘤彈簧圈栓塞手術後，我們回顧在小型三級醫療中心實施新的神經介入放射學計劃所面臨的挑戰。於2013年3月首次開始，我們的放射科是為大約500,000人口提供顱內動脈彈簧圈栓塞手術的唯一醫療機構。鑑於我們在建立該計劃時遇到的挑戰，我們希望分享有關爭取資源、早期溝通相關人士、並及時把我們的計劃介紹給面臨類似需求機構的經驗。

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Ethics Approval: To verify the quality of our newly implemented neurointerventional programme, we obtained local ethics approval to initiate a retrospective review of all patients who underwent cerebral coiling from March 2013 until December 2017.

BACKGROUND

Most commonly found at arterial bifurcations in the circle of Willis, intracranial aneurysms have a prevalence of 2% to 3%.[1] Rupture causes subarachnoid haemorrhage, which is associated with severe neurological impairment and a 30% to 40% fatality rate.[2] Prompt treatment of ruptured intracranial aneurysms by surgical clipping or endovascular coiling reduces morbidity and mortality by decreasing rebleeding and vasospasm.[3,4]

The first patient was treated with endovascular therapy in 1990,[5] with the United States Food and Drug Administration approval of the Guglielmi detachable coil in 1995. Endovascular coiling became the preferred treatment in 2002 when the International Subarachnoid Aneurysm Trial showed a significant benefit of endovascular treatment, with a 23.9% reduction in the relative risk of death or disability at 1 year compared to surgical clipping.[6]

Despite becoming one of the standard treatments for ruptured cerebral aneurysms, this interventional service is not uniformly available. Before a cerebral coiling service was established at the Health Sciences Centre, a small tertiary centre in the Canadian province of Newfoundland, all ruptured aneurysms from within the local population of 500,000 had to be transferred to a larger centre in the neighbouring province of Nova Scotia (1.5 hours by air) for endovascular treatment. In 2003, our Chief of Neurosurgery wrote a formal letter to our radiology department stating that it was 'imperative' that endovascular coiling of intracranial aneurysms 'be started as soon as possible at our institution' to reduce unnecessary treatment delays. Therefore, we began the daunting task of implementing a new neurointerventional service at our centre that would be permanently available around the clock.

Our Approach to Implementation

There are numerous factors to consider when implementing a new service, including costs, resource advocacy, specialised training, involvement of key stakeholders, and patient safety. Local administrative systems and funding should be considered from the onset. Our local healthcare system is publicly financed with revenue from federal, provincial, and territorial taxation. The Medical Care Plan is a comprehensive provincial insurance that covers the cost of physician services for patients, including hospital services. Physicians receive compensation by negotiating fee codes and billing Medical Care Plan for insured hospital services when recommended by a medical practitioner. Different specialists require separate fee codes for each procedure. New hospital services are approved by the Regional Health Authority Executive Team. Hospital departments have separate operating budgets, meaning that funding for a new neurointerventional radiology programme would largely need to come from our own budget. Unfortunately, we encountered many challenges that introduced significant delays that wasted time, resources, finances, and training.

Costs

We first considered the cost of implementing a new service, notably the significant upfront costs to develop the necessary infrastructure for neurointerventional procedures. We would need a new biplane angiography suite (US$2,024,000), a secondary multipurpose angiography suite for displaced cases (US$748,000), an inventory of coils and guidewires (US$352,000), departmental renovations (US$440,000), and salary for two additional nurses and one technologist.

We estimated that the cost-per-case would be lower if the service were performed at our centre, as we would avoid the costs of air transport (US$9303). However, we recognised that this was not necessarily a money-saving initiative. Our centre would reallocate the neurosurgery aneurysm clipping operating room time with other costly surgeries and available beds would be filled with other patients. Rather, the major benefit would be not transferring critically ill patients via air ambulance.

Resource Advocacy

With the support of the Department of Neurosurgery, we approached our hospital's Vice President of Medicine to request the necessary resources. There were numerous meetings in which we emphasised that deferred implementation of a coiling programme would result in substandard care. In 2006, our health authority requested US$3,564,000 in capital governmental funds to meet the upfront costs for programme implementation. Likely because of our partnership with the Department of Neurosurgery (those responsible for managing patient treatment plans and referrals to our services) and the recognition that this programme was necessary to meet the standard of care, a new biplane angiography suite was quickly approved and installed early in 2008.

Specialised Training

To prepare for programme implementation, we considered radiologist education. Two of our three interventional neuroradiologists had standard fellowship training at accredited Canadian institutions, which they finished in 2001 and 2005. Their fellowship training included intracranial aneurysm coiling techniques. The third and most senior neuroradiologist completed a cerebral coiling sabbatical in early 2008 in tandem with the installation of the biplane angiography suite. With 30 cases predicted yearly, our service would have a sufficient critical volume to maintain cerebral coiling expertise.

Unexpected Delays due to Late Involvement of Key Stakeholders

We were hopeful that we could begin coiling in the fall of 2008; however, we encountered further obstacles. Although casual conversations were conducted, we erred in not formally involving the Department of Anaesthesiology from the onset. Getting available anaesthesiologists was an obstacle, as the angiography suite was a new location for them to cover. Issues around fee codes had to be overcome, because the Departments of Radiology and Anaesthesiology each required separate fee codes for this new procedure to receive compensation. Furthermore, given the unscheduled and urgent nature of many coiling cases, additional overtime coverage was needed.

Just before implementation of the programme, we were required to complete a failure modes and effects analysis (FMEA), which is a systematic method of identifying where and how issues might arise (Figure 1). This process evaluated all anticipated failures at every step of patient treatment, from initial examination to discharge from the hospital after surgery, to calculate patient risk in all potential scenarios. Our quality assurance team ranked the severity, detectability, and probability of potential failures on a scale from 1 to 5 and calculated the criticality score from the product of these scores. An unacceptable risk to patients was defined as a score of 5 for severity or a criticality score of >20. An unacceptable risk score stalled the FMEA and required intervention by the quality assurance team to adjust procedures and policies or to provide additional training of staff that may be involved in the process flow to reduce risks to patients (Figure 1). After the intervention, the criticality score was recalculated, and this process was continued until all potential failures were assigned acceptable severity ranks and criticality scores to ensure that all considerations were made. This clarified our workflow and service model from the onset. For elective cases, neurosurgery is responsible for initial patient assessment and referral to interventional neuroradiology for aneurysms that can be clipped or coiled. Interventional neuroradiology will also assess the patient, discuss the procedure with the patient, and obtain informed consent. Elective patients are subsequently assessed in the Outpatient Preoperative Assessment Clinic by anaesthesiology. All specialists work together for patient care and can raise concerns regarding safety and the risk-benefit ratio for the patient. Neurosurgery is responsible for management after surgery, with the services again working collaboratively toward patient discharge. Patients are followed clinically by neurosurgery and follow-up imaging is completed by radiology, typically at 3 months after surgery and once per year thereafter. This arrangement is also followed for emergency patients, albeit on an accelerated timeline, with all assessments made in the hospital on an emergent basis. FMEA enabled us to pre-emptively improve patient safety by anticipating the logistical issues that may arise when beginning a new service. A proctor was present for our initial cases to aid in local programme implementation. Credentialing was necessary for this new procedure, which was based on the training of the interventional neuroradiologists and the volume of cerebral procedures needed to maintain competence.

Costs of Delays

Unfortunately, FMEA is a long process: it was not until March 2013 that all recommendations and actions were completed. We had returned the initial inventory of coils and other supplies obtained in 2008. Restocking in 2013 caused additional expense and frustration. Moreover, delays in programme implementation led to loss of expertise such that the two of our three interventional neuroradiologists required costly retraining. One of them completed additional training over the course of 6 months at an out-of-province high-volume centre. The other was unable to initially participate in retraining because of personal circumstances and is only now in the process of retraining, which meant the programme relied on the availability of two interventional neuroradiologists for years. While our service is offered around the clock, in rare contingency situations we have still have to transfer patients by air ambulance to a larger centre depending on the availability and expertise of the interventional neuroradiologists.

OUTCOMES OF OUR PROGRAMME IMPLEMENTION

To verify the quality of our newly implemented neurointerventional programme, we obtained local ethics approval to initiate a retrospective review of all

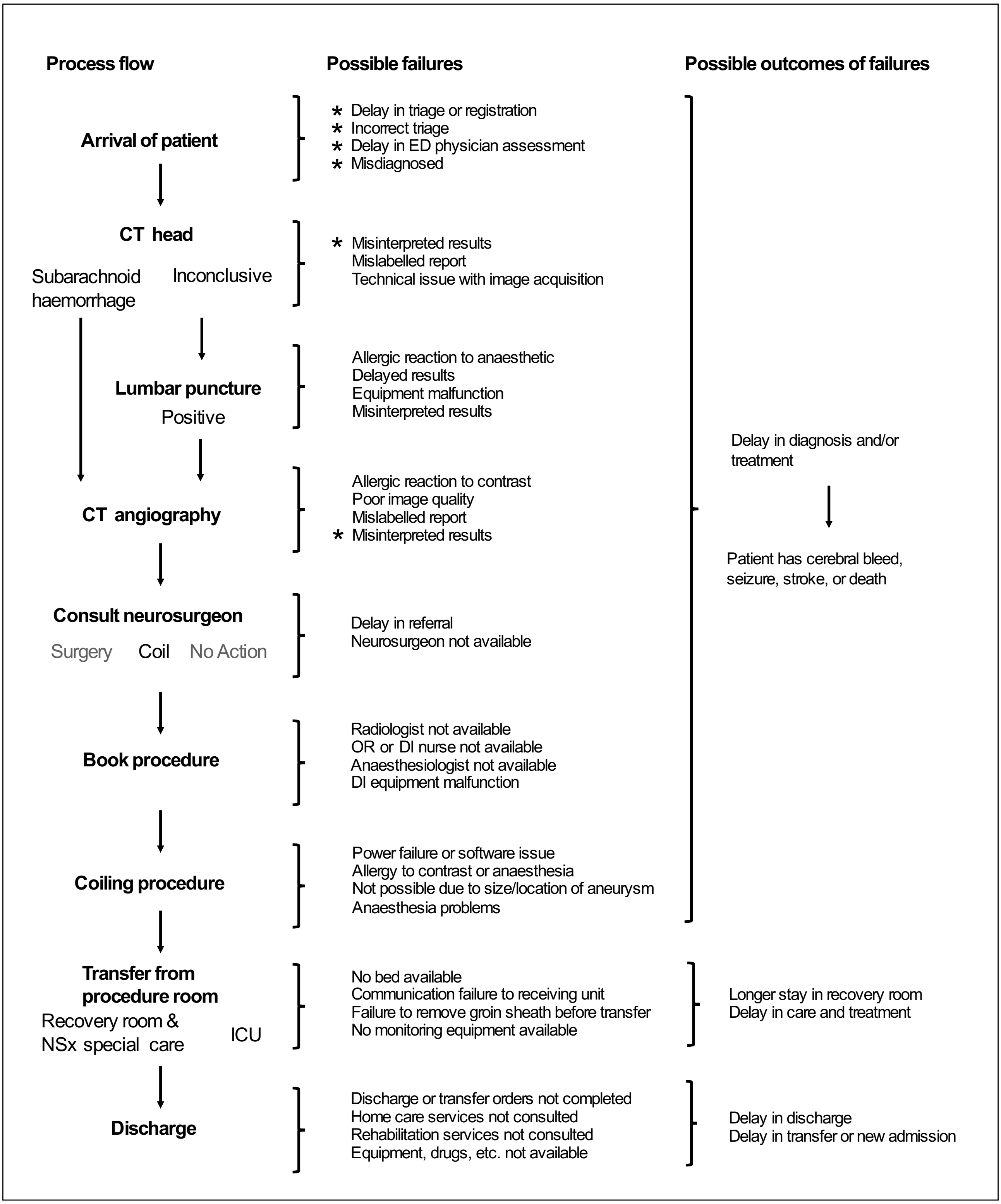

Figure 1. Condensed failure modes and effects analysis chart. This chart outlines the process flow that we developed for patients presenting to the Emergency Department with a ruptured aneurysm. Possible failures were identified for each step in patient care with awareness of the possible outcomes of each failure. Criticality scores were assigned to possible failures based on the anticipated severity, detectability, and probability of each system breakdown. Some failures required action to reduce risk to patients (marked with asterisks), whereas solutions were already in place to address other failures so that programme implementation could proceed.

Abbreviations: CT = computed tomography; DI = diagnostic imaging; ED = Emergency Department; ICU = intensive care unit; NSx = neurosurgery; OR = operating room.

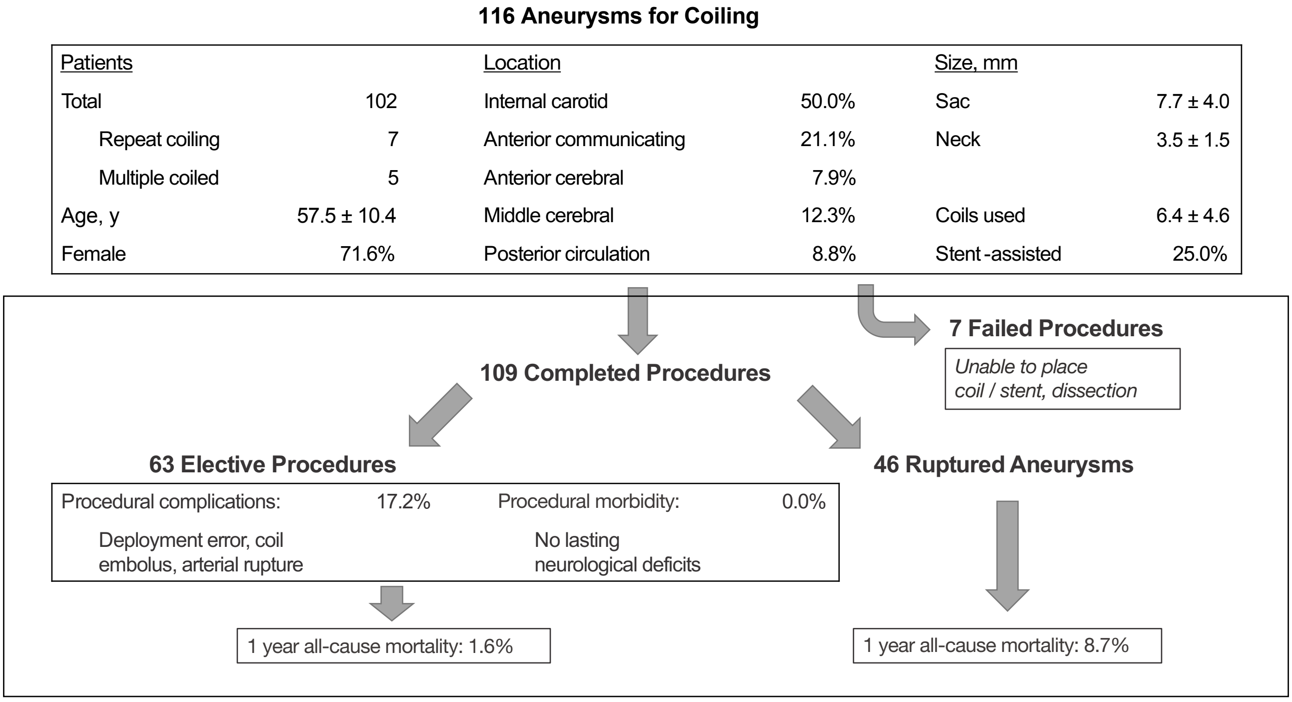

Figure 2. Audit infographic characterising all intracranial aneurysm coiling cases at our centre from March 2013 to December 2017, inclusive.

patients who underwent cerebral coiling from March 2013 until December 2017 (Figure 2). We found that 116 procedures were attempted on 102 patients, with seven failures due to coil or stent placement difficulties. Most aneurysms arose from the internal carotid artery and over half were coiled electively. Procedural complications encountered in the elective cases included deployment error, coil embolisation, and arterial rupture. As per follow-up neurosurgery examinations, there were no lasting neurological deficits in patients treated electively. Among those emergency cases with ruptured aneurysms, complications were similar, although transient thrombus formation was also frequently documented. Patients were followed up at 3 months after surgery and once per year thereafter with magnetic resonance angiography to rule out recurrence. The 1-year mortality was 1.6% for elective procedures and 8.7% for ruptured aneurysm repair. This is comparable to the literature.[7-9]

CONCLUSION AND FUTURE DIRECTION

The multi-year delay in our programme's implementation emphasises the need for early involvement of all necessary support disciplines as well as timely quality and safety assessments. Postponing radiologist retraining and consumable material consignment instead of purchase may save costs. Personnel and recruitment remain ongoing issues for our small centre given that our programme still relies on the availability of two interventional neuroradiologists. Other radiologists in our group absorbed the extra workload, which underscores the need for additional recruitment when new services are added. We believe FMEA was integral for anticipating patient safety concerns and ensuring a successful programme from the onset.

Ongoing advances in interventional radiology continually elevate the standard of care, leading to more advanced procedures being performed at smaller centres. This requires specialised suites with multidisciplinary staff, presenting unique challenges to radiology groups with limited resources and experience in programme implementation. By outlining the various obstacles that we faced, we hope other groups can better advocate for and streamline the introduction of new programmes so that they do not also experience multi-year delays. We now find this experience particularly pertinent as we are currently evaluating whether we can offer a sustainable endovascular thrombectomy programme for ischaemic stroke.

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