World Federation of Interventional and Therapeutic Neuroradiology (WFITN) Federation Assembly neurointerventional surgery safety checklist

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ABSTRACT

Over the last 10 years, there has been a rise in neurointerventional case complexity, device variety and physician distractions. Even among experienced physicians, this trend challenges our memory and concentration, making it more difficult to remember safety principles and their implications. Checklists are regarded by some as a redundant exercise that wastes time, or as an attack on physician autonomy. However, given the increasing case and disease complexity along with the number of distractions, it is even more important now to have a compelling reminder of safety principles that preserve habits that are susceptible to being overlooked because they seem mundane. Most hospitals have mandated a pre-procedure neurointerventional time-out checklist, but often it ends up being done in a cursory fashion for the primary purpose of 'checking off boxes'. There may be value in iterating the checklist to further emphasize safety and communication. The Federation Assembly of the World Federation of Interventional and Therapeutic Neuroradiology (WFITN) decided to construct a checklist for neurointerventional cases based on a review of the literature and insights from an expert panel.

INTRODUCTION

Safety risks to neurointerventional procedures are growing for many reasons. Over the last 10 years, there has been a rise in case complexity, device variety and physician distractions. All of these concerns can, even among experienced physicians, challenge our memory and concentration, making it more difficult to remember safety principles and their implications. The number of different neurointerventional devices and approaches now available are easily triple what was available just a few years ago. Lesions previously considered untreatable such as blister aneurysms, distal vessel occlusions and venous disease among many others are now considered to be within the scope of treatment possibilities. Distractions add to these risks. Often during the procedure, urgent and emergent consultations need to be managed which includes thinking about the case, scheduling and prioritization. Industry vendors may be present during the case who may be another source of distraction with their incentives and influence. The anesthesiologists, nurse anesthetists, radiology technologists, nurses, fellows and residents all caring for the patient often rotate with sometimes multiple handoffs occurring during a single case. Sometimes the level of engagement and understanding among all these people is surprisingly low. One survey of 300 surgical staff members at a Massachusetts hospital revealed that one in eight of the staff members did not know where the incision would be until the operation started.[1]

Checklists have been regarded by some as a redundant exercise that wastes time, or as an attack on physician autonomy. However, given the increasing case and disease complexity along with the number of distractions, it is even more important now to have a compelling reminder of safety principles that preserve habits that are susceptible to being overlooked because they seem mundane. Checklists can also foster better communication and teamwork within the procedure room and between clinical disciplines.[2] In 2009, the Safe Surgery Saves Lives team published in the *New England Journal of Medicine* a checklist that was used in eight sites around the world ranging from small district hospitals to large medical centers in diverse geographic settings. Checklist use reduced complications and mortality associated with a variety of surgical procedures by >30%.[3]

Checklists have received support from governing bodies such as the Interventional Radiological Society of Europe (CIRSE) and the Society of Interventional Radiology (SIR).[4 5] Fargen *et al*'s 2013 publication remains the only

Table 1 Selected checklist elements for image-guided procedures

	CIRSE	Fargen	WHO	SIR	RADPASS
Specialty	IR	NIR	Surgery	IR	IR
Number of elements	32	20	19	16	27
Publication year	2012	2013	2009	2016	2013
Before anesthesia/'sign In'					
Discussed with referring physician	X				
Clarify indications for procedure					X
Imaging studies reviewed	X		X	X	X
Relevant medical history	X		X		X
Confirm patient identity, procedure and consent	X	X	X	X	X
Mark site				X	X
Contrast-induced nephropathy prophylaxis	X			X	X
Check labs	X			X	X
Check pulses					
Determine if anticoagulation needed	X				
Determine if arterial line needed		X			
Evaluate for contrast/anesthetic allergy	X	X		X	X
Determine if difficult airway/aspiration risk		X			X
Pregnancy status		X		X	
Correct patient name in computer		X			
Check equipment/anesthesia machine			X		X
Devices available	X				
Post-interventional bed required	X				X
IRMER requirements met			X	X	
Check risk factors for bleeding/renal failure			X	X	
Antibiotic prophylaxis given			X	X	
Venous thromboembolism prophylaxis			X		
Review critical/unexpected steps with team			X		
Determine type of anesthesia/sedation				X	X
Type and screen				X	
Contraindications identified					X
Medications for procedure available					X
Before vascular access/'time out'					
Introduction of all team member names and roles	X	X	X		
All records with patient	X				
Confirm patient NPO	X				
Confirm adequate IV access	X				X
Confirm monitoring equipment attached	X		X		
Check equipment			X		
Confirm patient name/procedure/side	X	X	X		
Does patient have difficult airway			X		
Patient ASA grade			X		
Procedure summary		X			
Sheath size		X			
Initial catheter and size		X			
Number of pressure bags		X			
Planned devices		X			
Tortuosity concerns		X			
Pulses palpated		X			

Continued

Table 1 Continued

	CIRSE	Fargen	WHO	SIR	RADPASS
Patient weight		X			
Maximum contrast dose		X			
Patient creatinine		X			
Heparin needed		X			
Antithrombotics		X			
Antibiotics	X		X		X
Glycemic control			X		
Patient warming			X		
Hair removal			X		
Radiation protection					
Consent discussed	X				X
Before patient leaves room/'sign out'					
Vascular closure method confirmed		X			
Total contrast dose given		X			
Distal pulse status confirmed		X			
Any equipment problems reported		X	X		
All invasive equipment accounted for			X		
All implanted devices recorded			X		
Assign sign out to primary team and family		X			
Sheath removed					
Medication prescribed					
Radiation dose limit reached		X			
Post-op note written	X				X
Vital signs normal during procedure	X				
Medications recorded	X				
Lab tests ordered	X				
Samples labeled and sent to lab	X		X		X
Discuss results with patient/family	X				X
Post-discharge instructions given	X		X		X
Follow-up testing/imaging ordered	X				X
Discuss results with referring physician	X				X
Imaging sent for archiving					X
Process billing code					X

ASA, American Society of Anesthesiologists; CIRSE, Interventional Radiological Society of Europe; IR, interventional radiology; IRMER, Ionising Radiation (Medical Exposure) Regulations; IV, intravenous; NIR, neurointerventional radiology; NPO, nothing by mouth; RADPASS, RADiological Patient Safety System; SIR, Society of Interventional Radiology; WHO, World Health Organization.

neurointerventional-focused preprocedural checklist. It consists of a three-part, 20-item checklist using the WHO surgical checklist as a foundation. They found among staff, after checklist implementation, communication significantly improved compared with before the use of checklists. They also found a lower number of adverse events. Ninety-five per cent of respondents indicated that checklists should be continued.[6]

Most hospitals have mandated a pre-procedure neurointerventional time-out checklist, but often it ends up being done in a cursory fashion for the primary purpose of 'checking off boxes'. There may be value in iterating the checklist to further emphasize safety and communication. Since it has been 10 years since the introduction of a published neurointerventional preprocedural checklist, iterative adaptations are overdue. The Federation Assembly of the World Federation of Interventional and Therapeutic Neuroradiology (WFITN) decided to construct a checklist for neurointerventional cases based on a review of the literature and insights from an expert panel. This will then be distilled down to three goals and a proposed checklist that reinforces these goals. It is expected that this checklist would not be used verbatim, but adapted to the specific needs of individual practices.

LITERATURE REVIEW ON IMAGE-GUIDED INTERVENTIONAL PROCEDURE CHECKLISTS

A recent systematic review of checklists for image-guided interventions provides an overview of commonly proposed checklist elements, effectiveness, and barriers to adoption. In this review,[7] of 16 studies, the large majority described checklists for body/vascular interventional radiology with only one publication each for pediatric interventional radiology and neurointerventional radiology. Most did not report data measuring checklist

Table 2 WFITN neurointerventional surgery procedure checklist

Before anesthesia 'sign-in'	Before access 'time out'	Before leaving room 'sign-out'
Confirm patient name	Introduce names	Neurologic exam unchanged?
Confirm procedure	Brief procedure overview	Distal pulses unchanged?
Consent obtained?	Any anticipated difficulties during procedure	Total contrast given
Is relevant imaging available to review on monitors?	Anticipated procedure length	Total radiation dose
What allergies does patient have?	Patient monitoring equipment sufficient	Debrief near-misses and record if a complication occurred.
What antithrombotics is patient already taking?	For pediatrics: maximum contrast dose	Postoperative note dictated?
Does patient need contrast toxicity prophylaxis?	Anticipated medications, ie, heparin, eptifibatide, verapamil, protamine, atropine	Family contacted?
Any abnormal bloodwork?	Ask entire team if any questions	Referring physician contacted?
Patient pregnant?	Anesthetic concerns?	Follow-up medication/imaging ordered?
Equipment functioning properly?	Radiation protection sufficient including anesthesia?	Sign out to next team with potential neurologic deficits, blood pressure goals
Are any pulses weak at baseline?	Anticipated devices available?	Samples sent to lab?
Patient NPO?	Access site(s) chosen?	Any equipment problems?

NPO, nothing by mouth; WFITN, World Federation of Interventional and Therapeutic Neuroradiology.

effectiveness. There were no randomized controlled trials or formal quality assessments. As a result, there was significant heterogeneity among studies.

Nevertheless, the majority of checklists had three domains, usually corresponding to (1) sign-in (before anesthesia induction), (2) time-out (before beginning the actual procedure) and (3) sign-out. The number of checklist items ranged from 4–40. Five were adapted from the WHO checklist and three adapted from the Universal Protocol. A compilation of five of the most often cited image-guided preprocedural checklists are shown in table 1 which show substantial heterogeneity in the elements included.

Whether checklist implementation actually reduces complication rates, avoids near-miss adverse events, identifies process issues or reduces process deviations is not well studied. The best outcome measures thus far consist only of surveys to assess attitudes of healthcare providers towards checklists. They have been generally perceived as important tools to improve teamwork, communication and patient safety.

However, many of the reviewed articles did describe barriers to checklist use. These included excessive checklist length, lack of leadership, and poor awareness of the importance of checklists. A busy practice focused on efficiency and throughput as well as lack of applicability of certain checklist elements have also been described as barriers. Possible interventions to address these barriers include the use of a multidisciplinary team that designs a program-specific checklist that periodically iterates by addressing staff concerns and encouraging participation in the modifications.

Of all the published checklists, there seemed to be one primary model that was adopted. Those designed from the WHO Surgical Safety Checklist emphasized improved communication and teamwork within the procedure room. It emphasized fewer checking off boxes and more team member engagement.

GOALS

1. Improve teamwork and communication

The Joint Commission analyzed 2455 sentinel events and found the primary root cause in over 70% was communication failure.[4] The checklist may serve to democratize the procedure by facilitating everyone in the room to be more accountable and communicate more during the procedure.[8] For example, communicating exactly what devices are needed beforehand may help the technologist be more aware of what will most likely be needed to decrease the chance of inadvertent or accidental opening of expensive products. Particularly now that device variety has increased, there is an even greater need to have mechanisms to minimize opening the wrong product.

Before beginning the procedure, everyone should face each other and introduce themselves with names. This should take 10 seconds. Particularly in larger hospitals, there are many people who rotate through the neurointerventional suite. It is easier to remember someone's name while facing them. This stage of the time-out is when a collection of individuals transforms into a team.

The attending/fellow physician should be able to state in 1–2 sentences an overview of the case. This should take 30 seconds. The overview can include the patient's problem, the anticipated procedure, the level of complexity, critical portions and what the primary concerns are. Providing essential context to everyone on the team assists with engagement, particularly among the technologists, who do not routinely evaluate patients preoperatively. This information then helps everyone track the progress as the case unfolds and even anticipate times of high acuity/complexity and be prepared to contribute.

Allow time for questions, which should take, at most, 1–2 min. It is better to raise issues early than during/after the case. This is particularly helpful for critically ill patients or those with multiple high acuity comorbidities. It is difficult to know what details are extraneous or vital to the outcome of the case. This process helps to ensure seemingly unimportant but potentially critical details are not overlooked. Examples include reliability of intravenous access, blood pressure monitoring methods, trends in vital signs, etc. The aim is to decrease barriers to voicing safety concerns. Foreshadowing concerns may prepare the team to respond more calmly and effectively if they do become a concern.

After the case, debriefing is an investment for future cases and should take at most 1–2 min. A discussion after the case allows for reflection on what went well, what was learned, near misses, complications, and any steps to improve the process next time. It is iterative and allows every team member to voice their thoughts so that the collective wisdom of the team continues to grow with each case.

2. Radiation safety for the patient and staff

As the procedure length and complexity in neurointerventional procedures increases, so does the risks of radiation exposure. This carries risks not just to the patient but also the staff, particularly for pediatric patients. This often overlooked risk may particularly benefit from inclusion into preprocedural checklists as it helps maintain appropriate habits.

The checklist should reinforce appropriate radiation shielding for the operator, including leaded glasses, lead aprons with thyroid shields, appropriate use of ceiling suspended leaded acrylic shields and standing upright leaded acrylic shields. Measures to reduce patient and staff radiation exposure include keeping the image intensifier as close to the patient as possible, minimizing time of actual fluoroscopy, keeping distance from the radiation source, and shielding. All of these measures are easy to overlook and if neglected, over time, can lead to years of unnecessary ionizing radiation exposure.

Appropriate protection for the anesthesiologist is sometimes an afterthought. One study found that radiation exposure for the anesthesiologist during interventional procedures was threefold more than the operator.[9] Although conventional for the operator to wear leaded glasses and to use ceiling mounted leaded shields, no similar convention exists for anesthesiologists. The anesthesiologists may simply be unaware. Similarly, the orientation of the arms of the biplane machine, specifically the lateral arm X-ray source on the side of the anesthesiologists, leads to scatter reflecting towards anesthesia personnel. Highlighting radiation safety concerns for the patient and staff in the preprocedural checklist repeatedly brings these concerns to the forefront, and makes it easier for everyone on the team to develop good habits and police each other to make sure these measures are maintained throughout the procedure.

3. Complication prevention in neurointerventional surgery

A systematic review of studies looking at medical errors in interventional radiology procedures suggested that most errors are non-technical and that between 55–84% are preventable.[10] Preventing complications would intuitively value reinforcing safety principles, teamwork and communication. The often overlooked but essential things, like checking the pressurized drip lines periodically, or monitoring anticoagulant administration, or an extra pair of eyes to ensure procedure sterility/contrast load/radiation exposure, or even looking at the monitor for concerns on imaging, become the team's concern.

Particularly in emergent settings, where complications may occur more often, the value of checklists has been studied.[11] In 1750 consecutive urgent surgeries, the latter 908 surgeries which employed the WHO safe surgery checklist yielded a 6.7% reduction in major complications (18.4% pre, 11.7% post; P=0.001) and a 2.3% reduction in mortality (3.7% pre, 1.4% post, P=0.0067).

Neurointerventional procedures are inherently complex and have high stakes. A checklist that increases team accountability and communication may directly help mitigate the occurrence of and/or harm associated with complications.

WFITN NEUROINTERVENTIONAL SURGERY PROCEDURE CHECKLIST

In order to be useful, however, the checklist has to be, above all else, practical. The focus should not be on checking off boxes, or generating a how-to guide. It should be designed to build the foundation for future effective communication during the case. Taking Fargen's checklist as a framework, we decided to review all prior image-guided procedure checklists published and select those elements that promote team communication, radiation safety and complication prevention. At the same time, effort must be made to only include the most essential items because longer checklists will discourage adoption. Table 2 outlines, in three sections, critical elements to be included in a neurointerventional checklist.

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