“Team time-out” and surgical safety—experiences in 12,390 neurosurgical patients

ÁGI OSZVALD, M.D.,¹ HARTMUT VATTER, M.D., PH.D.,¹ CHRISTIAN BYHAHN, M.D., PH.D.,² VOLKER SEIFERT, M.D., PH.D.,¹ AND ERDEM GÜRESİR, M.D., PH.D.¹

Departments of ¹Neurosurgery and ²Anesthesiology, Intensive Care Medicine, and Pain Therapy, Johann Wolfgang Goethe University, Frankfurt am Main, Germany

Object. Quality and safety are basic concerns in any medical practice. Especially in daily surgical practice, with increasing turnover and shortened procedure times, attention to these topics needs to be assured. Starting in 2007, the authors used a perioperative checklist in all elective procedures and extended the checklist in January 2011 according to the so-called team time-out principles, with additional assessment of patient identity and the planned surgical procedure performed immediately before skin incision, including the emergency cases.

Methods. The advanced perioperative checklist includes parts for patient identification, preoperative assessments, team time-out, postoperative treatment, and imaging controls. All parts are signed by the responsible physician except for the team time-out, which is performed and signed by the theater nurse on behalf of the surgeon immediately before skin incision.

Results. Between January 2007 and December 2010, 1 wrong-sided bur hole in an emergency case and 1 wrong-sided lumbar approach in an elective case (of 8795 surgical procedures) occurred in the authors' department. Using the advanced perioperative checklist including the team time-out principles, no error occurred in 3595 surgical procedures (January 2011–June 2012). In the authors' department all team members appreciate the chance to focus on the patient, the surgical procedure, and expected difficulties. The number of incomplete checklists and of patients not being transferred into the operating room was lowered significantly ($p = 0.002$) after implementing the advanced perioperative checklist.

Conclusions. In the authors' daily experience, the advanced perioperative checklist developed according to the team time-out principles improves preoperative workup and the focus of the entire team. The focus is drawn to the procedure, expected difficulties of the surgery, and special needs in the treatment of the particular patient. Especially in emergency situations, the team time-out synchronizes the involved team members and helps to improve patient safety.

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KEY WORDS • surgical checklist • patient safety • neurosurgery

SAFETY and quality are basic concerns in any medical practice. Based on aviation guidelines, checklists for medical needs were developed in different medical fields to decrease errors of omission, improper implementation of procedures and protocols, and human error, especially under stressful conditions. Medical fields with complex medical situations or emergency and crisis management, such as anesthesiology and emergency medicine, already use checklists to improve quality and safety.

Especially in daily surgical practice with increasing turnover of surgical procedures, attention to quality and safety needs to be assured. To have a traceable and documented preoperative preparation of all patients undergoing any elective surgical procedure, we used a preoperative checklist in all elective surgical procedures starting in 2007. The publication of the Surgical Safety Checklist in January 2009⁶ as well as the effect of the SURPASS (SURgical Patient Safety System) on patient

outcome in November 2010⁴ led to reevaluation of our preoperative management. Therefore the checklist was extended in January 2011 according to the team time-out principles to assess the patient's identity and data about the procedure prior to incision. In addition, the advanced perioperative checklist was performed in all surgical procedures including the emergency cases. The aim of the present study was to demonstrate the implementation of an advanced perioperative checklist and to analyze its effect, and also to evaluate the feasibility of the checklist as well as the safety of the procedure and the occurrence of perioperative errors in a neurosurgical center.

Methods

Starting in 2007, a perioperative checklist for all elective neurosurgical procedures was established to confirm complete preoperative workup. This workflow and check-

list was developed to increase safety for all patients undergoing elective surgery. In addition, the preoperative workflow was standardized by the perioperative checklist.

We designed an accompanying perioperative checklist for each patient based on the perioperative workflow. The perioperative checklist was printed on red paper to be easily visible in the patient's record. The checklist was labeled with the individual's admission number, name, and date of birth for immediate preoperative identification.

Perioperative Checklists

The workflow was divided into different parts that had to be completed at a particular time. Within the perioperative checklists (Figs. 1 and 2), one of the parts included the preoperative workup and had to be checked and signed by the physician in charge. The following key points were verified: the planned surgical procedure, the side of surgery, patient's written informed consent, absence of major pathological findings in blood tests, result of blood type testing, anesthesiologist's approval, and availability of all necessary images. The patient identification was verified by the theater nurse before admission to the operating room. No patient undergoing elective surgery was to be transferred to the operating room without a completed and signed perioperative checklist. Patients being transferred to the operating room with an incomplete checklist were sent back to the ward.

Another part of the checklists included patient identification by the anesthesiologist before starting anesthesia, and this had to be signed. This part included verification of the attached identification wristband, patient verification of his or her identity, verification of the side of the surgical procedure, signed written informed consent, known allergies, a history of airway-related problems, estimated intraoperative blood loss > 500 ml, and existence of any implants. The intraoperative part was processed after the patient was positioned and ready for the surgical procedure. In the initial perioperative checklist, the physician assisting the surgery approved the correct positioning of the patient and the side of the surgical procedure. The physician performing the surgery had to give a second, independent approval of the side of the surgical procedure. The next part was completed postoperatively by the physician performing the surgery, for patients being transferred to the ICU after surgery. The physician in charge at the ICU needed to countersign this part of the checklist after the verbal report of the surgeon about the surgical procedure and postoperative handling.

The experiences of processing the perioperative checklist for elective surgical procedures led to an interdisciplinary discussion about ways to further increase the safety in all surgical procedures, including emergency cases. Despite the existing perioperative checklist, errors occurred; therefore the 4-year experience (2007–2010) of the perioperative checklist was reevaluated and an advanced perioperative checklist was developed.

In the advanced perioperative checklist, 2 further parts were included (Fig. 2). The first part had to be checked and signed by the nursing team of the ward as preoperative preparation. The following points had to be

checked: attached identification wristband, the patient's skin condition, proper function of the patient's bed, and patient's preparation (shave, removed jewelry, removed dental prostheses, compression stockings, and so on).

Furthermore, the team time-out principles were evaluated and implemented into the existing checklist.^{6,8} The team time-out was verbally processed by the entire team immediately prior to skin incision, and was signed by one of the team members on behalf of the surgeon. The following points were checked: all team members introduce themselves (name, department, and position), all team members confirm patient's identity, side of the procedure and planned procedure, correct positioning of the patient. Expected critical points of the procedure are announced by the surgeons (planned surgical steps, duration of surgery, expected blood loss); by the anesthesiologist (ventilation or sedation problems); and by the nursing staff (sterility and availability of the needed equipment). Finally, antibiotic prophylaxis and the availability of relevant images are reconfirmed.

The advanced perioperative checklist became mandatory for all surgical procedures, including emergency cases.

The patient was transferred and admitted to the operating room without a completed advanced perioperative checklist in emergency cases. However, the first 2 parts of the advanced perioperative checklist were at least partially completed by the surgeon on call in the operating room. The other parts of the advanced perioperative checklist were completed as described above.

Statistical Analysis

Statistical analyses were performed with commercially available software (SPSS Statistics version 20). Dichotomous data were assessed using the chi-square or Fisher exact test. A *p* value < 0.05 was considered statistically significant.

Results

Between January 2007 and June 2012, the authors performed 12,390 surgical procedures, including 9068 elective and 3322 emergency procedures. The perioperative checklist was used between January 2007 and December 2010 in all elective surgical procedures. Between January 2011 and June 2012, the advanced perioperative checklist was used in all surgical procedures (elective and emergency surgical procedures).

Perioperative Checklist

In the 4-year period (January 2007–December 2010), the preoperative checklist was used in 6322 elective surgical procedures of 8795 surgeries performed in total, and in none of the 2473 emergency cases.

During this time period, 1 wrong-sided bur hole in an emergency case and 1 wrong-sided lumbar approach in an elective case were performed in our department (2 [0.03%] of 6322). The wrong-sided bur hole was performed in an emergency case of a patient with acutely decompensated chronic subdural hematoma. Due to the rapidly deteriorating neurological status of this patient, everyone involved

Perioperative checklist

Filling in all the blanks is mandatory. The physician in charge is responsible for complications resulting out of missing or misstated data.

Preoperative Checklist (to be completed before transport to the OR)

Last Name: _____ Planned operation: _____
First Name: _____
DOB: _____ Side of surgery: _____

Patient informed and ☐ Laboratory tests OK? ☐
Informed consent signed?
Relevant images present? ☐ Premedication Document OK? ☐

Signature physician in charge

Transfer into the OR (to be completed before anesthesia)

Patient Identified? personally ☐
based on patient record ☐

Signature anesthetist

Intraoperative Checklist (to be completed before operation)

Patient Identified? personally ☐
based on patient record ☐

Side of approach? _____ Side of approach? _____
Positioning of the patient checked? (eyes, limbs) ☐

Signature assisting surgeon

Signature surgeon

Transfer to ICU or anaesthetic recovery room (to be completed before transfer the patient out of the OR)

Intraoperative pathologies:
Surgical procedure performed:
Specific conditions during operation:
Deviating postoperative orders:
Drainage:

Signature surgeon

Signature physician ICU

Fig. 1. Perioperative checklist—this checklist was used between January 2007 and December 2010 in all elective surgeries.

in the procedure tried to save time. Preparing the patient, positioning, and management of the anesthetic were performed all at the same time. At that time the perioperative checklist was not used in emergency surgical procedures.

In the case of the wrong-sided lumbar approach, patient positioning and preparation of the surgical field were done as usual. After radiological identification of the

correct lumbar level, surgery was started—this was the third consecutive lumbar approach for the surgical team on this day. No lumbar disc herniation was detected. At that point the error of the wrong-sided approach was realized and the operation was switched to the other side. The lumbar disc herniation was detected and postoperatively the patient had no residual pain or deficits. The checklist

Perioperative Checklist

Department of Neurosurgery of the Johann Wolfgang Goethe-University

Patient label		Planned surgical procedure:	
		Side of surgery :	
Preoperative <ul style="list-style-type: none"> ☐ patient's wristband ☐ dermatologic condition evaluated ☐ beds checked ☐ nursing preparation done (shave, dental prostheses removed, compression stockings) 	Pre anaesthetic <ul style="list-style-type: none"> ☐ patient's wristband ☐ patient confirms: <ul style="list-style-type: none"> - patient's identity - body side - procedure ☐ Informed Consent ☐ body side marked ☐ anesthetic check complete Has the patient: <ul style="list-style-type: none"> - known allergies? ☐ yes ☐ no - respiratory problems? ☐ yes ☐ no - a risk for blood loss >500 ml? ☐ yes ☐ no - implants ☐ yes ☐ no 	Before skin incision <ul style="list-style-type: none"> ☐ all team members introduced? ☐ surgeon, anesthetist and theatre nurse verbally confirm: <ul style="list-style-type: none"> - patient's identity - body side - Procedure ☐ patient's position checked Checking of critical points: <ul style="list-style-type: none"> ☐ surgery: critical/unexpected surgical steps ☐ op-time, blood loss? ☐ anesthesia: patient specific concerns/problems? ☐ nursing: sterility ensured? antibiotic prophylaxis < 60 minutes: ☐ yes ☐ not necessary relevant images present? ☐ yes ☐ not necessary 	Before transfer out of the OR <ul style="list-style-type: none"> ☐ theatre nurse verbally confirms to the team: <ul style="list-style-type: none"> - documented procedure - completeness of instruments, needles and cottons - labelling of specimen, including the patient's name - existing problems with the equipment used
Nursing (Date, Name, Signature) <ul style="list-style-type: none"> ☐ patient informed ☐ Informed Consent signed ☐ requested images, results, laboratory tests ok. ☐ preoperative clinical diagnostics completed ☐ premedication file complete ☐ blood reserves ordered ☐ blood reserves not necessary ☐ blood type determined 	Surgeon (Date, Name, Signature) <ul style="list-style-type: none"> ☐ surgeon and anesthetist check the basic points of the postoperative patient management 		
Ward physician (Date, Name, Signature)	Anesthetist (Date, Name, Signature)	Surgeon (Date, Name, Signature)	Anesthetist (Date, Name, Signature)

FIG. 2. Advanced perioperative checklist—this checklist was adapted according to Haynes et al., and used between January 2011 and June 2012. (Based on the WHO Surgical Safety Checklist, http://whqlibdoc.who.int/publications/2009/9789241598590_eng_Checklist.pdf, © World Health Organization 2009. All rights reserved.)

at this time did not yet include further identification of the patient immediately before skin incision, nor the specific procedure or the side of the surgical procedure. In both cases the errors could be corrected right away in the same surgical procedure, and the patients had a good outcome without any residual deficits, except a second scar on the head for the patient in Case 1.

Advanced Perioperative Checklist

Between January 2011 and June 2012 no error occurred in 2746 elective and 849 emergency cases (total of 3595 surgical procedures). Everyone on the surgical team appreciated the advanced perioperative checklist, especially the team time-out procedure, which was a general pause for everyone in the surgical team.

In both time periods 9917 surgical procedures (6322 from 2007–2010 and 3595 from 2011–2012) in total were included, in which perioperative and advanced perioperative checklists were performed. In the time period during which the advanced perioperative checklist was used, more surgical procedures per year were performed ($p = 0.0005$; OR 0.8, 95% CI 0.7–0.9).

Overall, an incomplete checklist was found in 290 patients (3%) during the whole time period. In the early time

period with the perioperative checklist, a significantly higher number of patients had incomplete checklists (215 patients [3%] vs 75 patients [2%]) compared with the late time period with the advanced perioperative checklist ($p = 0.0002$; OR 1.7, 95% CI 1.3–2.2). Of the 290 incomplete checklists (checklists that were either incomplete or missing signatures of the physicians in charge), 238 (2%) were found to be incomplete before transferring the patient into the operating room. Overall 52 patients (0.5% of both checklists) were transferred to the operating room despite an incomplete checklist, and 10 of the 52 patients (0.1%) had to be removed from the operating room and sent back to the ward because of missing data, preparation, laboratory tests, or images.

One hundred seventy-five patients (3%) with an incomplete perioperative checklist, and 63 patients (2%) with an incomplete advanced perioperative checklist were not transferred to the operating room ($p = 0.002$; OR 1.6, 95% CI 1.2–2.1). Therefore, useless transports to the operating room or even started anesthesiology procedures could be reduced significantly with the advanced perioperative checklist. Comparing the number of patients being transferred into the operating room with incomplete checklists between the perioperative (40 of 52 patients)

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and the advanced perioperative (12 of 52 patients) checklist, no significant difference could be found (Table 1).

Discussion

Beyond the medical field—for example in the airline industry, the military, and the technical control board (a government agency for technical standards in any industrial branch)—checklists are used as an established safety system. It has been proven that checklists improve the quality and safety of procedures or production, minimize errors, and increase the efficiency of the procedure.^{1,5}

Checklists in general can serve as an important tool to ensure patient safety and minimize errors. Using a checklist helps to standardize processes and procedures, especially in emergency situations. The effectiveness of existing checklists can only be assured by the participation of the whole team included in that particular procedure. Therefore, checklists need to be continuously evaluated and revised if necessary to guarantee constant quality and accuracy.⁵

In our department we implemented a perioperative checklist in 2007 after interdisciplinary discussion about problems, complications, and errors in the perioperative preparation. Everyone involved was eager to have an uncomplicated checklist to minimize additional workload and waiting time in the operating room. Before 2007 patients were occasionally admitted to the operating room without complete preoperative workup; for example, missing tests or data were not recognized during the transfer into the operating room. In cases of missing data, additional time was needed to check these data or even to assess missing tests. This resulted in significant delay of the surgical procedure and prolonged anesthesia

time. Therefore the need and benefit of a checklist was obvious for anyone involved, and resulted in the use and performance of the perioperative checklist. Boström et al.² described in a prospectively conducted observational study the preoperative mismanagement or incomplete preoperative workup in 33.2% of all neurosurgical procedures. Comparing the data of Boström et al. to our data after implementing the perioperative checklist, preoperative mismanagement leading to delay of the surgery or prolonged anesthesia is dramatically lower (0.6%).

Several studies discuss the moderate compliance of the use and performance of medical checklists.^{3,4,6,7} In our department we did not experience a decreasing compliance in use and performance of the perioperative checklist over the years. In this study, the number of incomplete checklists was significantly lower after implementing the extended advanced perioperative checklist compared with the previous time period (January 2007–December 2010). In addition, the number of patients being transferred into the operating room with incomplete checklists decreased significantly with the extended advanced perioperative checklist. The increase in complete checklists and increased awareness of everyone involved in patient identification and therefore correct preoperative workflow, even with the extended checklist, may be the result of expanding the responsibility for the preoperative workup to the nursing staff. The obvious benefits in surgical procedures being prepared with minimized missing data increased the compliance of everyone involved. However, a limitation of the present study is the retrospective style of data analysis.

The advanced perioperative checklist according to the team time-out principles⁶ can further improve the safety of the surgical procedure, especially in emergency cases. The wrong-sided bur hole was performed in an

TABLE 1: Performance of perioperative checklists in 12,390 neurosurgical cases

Variable	Jan 2007–Dec 2010; Periop Checklist	Jan 2011–June 2012; Advanced Periop Checklist	Total
no. of surgical procedures			
elective*	6,322	2,746	9,068
emergency	2,473	849	3,322
all	8,795	3,595	12,390
no. of performed checklists	6,322	3,595	9,917
no. (%) transferred to surgery w/			
complete checklist†	6,107 (97)	3,520 (98)	9,627 (97)
incomplete checklist	215 (3)	75 (2)	290 (3)
no. (%) w/ realization of incomplete checklist			
before transfer to surgery‡	175 (3)	63 (2)	238 (2)
after transfer to surgery§	40 (0.6)	12 (0.3)	52 (0.5)
removed from surgery¶	8 (0.1)	2 (0.06)	10 (0.1)
no. of errors (%)**	2 (0.03)	0 (0)	2 (0.02)

* $p = 0.0005$; OR 0.8 (95% CI 0.7–0.9).

† $p = 0.0002$; OR 1.7 (95% CI 1.3–2.2).

‡ $p = 0.002$; OR 1.6 (95% CI 1.2–2.1).

§ $p = 0.07$.

¶ Patients removed from the operating room after being transferred there with an incomplete checklist; $p = 0.5$.

** $p = 0.74$; OR 2.8 (95% CI 0.1–59.3).

emergency case involving a patient with acutely decompensated chronic subdural hematoma. In emergency situations the preoperative workup of the patient is performed in the operating room while the patient is positioned and the instruments are prepared by the theater nurses. In retrospect, the additional team time-out procedure could have focused everyone in the operating room, similar to a general pause, by verbally recalling the surgical procedure and the side of the procedure.

Conclusions

The perioperative checklist minimizes incomplete preoperative workup and missing data, laboratory tests, or images compared with data in the literature analyzing neurosurgical errors.² The team time-out procedure itself is a personal, verbal operation and therefore cannot be performed half-heartedly as simple marked checks. Everyone involved must listen and focus on the patient and the planned procedure. Particularly in emergency cases, when many procedures run parallel to shorten the preoperative patient preparation, the advanced perioperative checklist synchronizes the different parties involved and helps to realize any problems evolving. Therefore, an advanced perioperative checklist can improve the safety and efficacy of elective surgical procedures. Furthermore, the additional team time-out procedure helps to improve the preparation and safety of the patient, even in emergency surgeries.

Disclosure

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author contributions to the study and manuscript preparation include the following. Conception and design: Oszvald, Seifert, Güresir. Acquisition of data: Oszvald. Analysis and interpretation of data: Oszvald, Vatter. Drafting the article: Oszvald, Güresir. Critically revising the article: Byhahn, Seifert, Güresir. Reviewed

submitted version of manuscript: Vatter, Byhahn, Seifert, Güresir. Statistical analysis: Oszvald.

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Address correspondence to: Ági Oszvald, M.D., Department of Neurosurgery, Johann Wolfgang Goethe University, Frankfurt am Main, Schleusenweg 2-16, 60528 Frankfurt am Main, Germany. email: Oszvald@em.uni-frankfurt.de.