German military neurosurgery at home and abroad

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For many years, the experience of neurosurgeons from the German Armed Forces was limited to the peacetime care of patients in Germany. In 1995, German military neurosurgeons were deployed abroad for the first time. Since the beginning of the International Security Assistance Force mission, there has been a rapidly increasing number of opportunities for military neurosurgeons to broaden their experience during deployments abroad.

Since the first deployment of a neurosurgeon to the German field hospital in Mazar-e-Sharif, Afghanistan, a total of 140 neurosurgical procedures have been performed there. Sixty-four surgeries were performed for cranial or spinal neurotrauma management. During the entire period, only 10 International Security Assistance Force members required acute or urgent neurosurgical interventions. The majority of neurosurgical procedures were performed in Afghan patients who received acute and elective treatment whenever the necessary infrastructure was available in the field hospital. Fifteen patients from the Afghan National Army and Police and 115 local patients underwent neurosurgery. Sixty-two procedures were carried out under acute or urgent conditions, and 78 operations were elective.

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KEY WORDS • military neurosurgery • history of military neurosurgery • Afghanistan • International Security Assistance Force

History of German Military Neurosurgery

In Germany, the first surgical procedures involving the nervous system were performed by physicians who had started training in surgery or neurology and who had been influenced by events in World Wars I and II. In 1934, Wilhelm Toennis (1898–1978) established the first independent neurosurgical department in Germany in Wuerzburg. In 1936, he founded the first ever neurosurgical journal. During World War II, he became brigadier general in the medical corps of the German Air Force and was awarded the Knight's Cross with Swords for meritorious service on May 31, 1944. He organized the neurosurgical management of wounded military personnel and the air evacuation of patients with brain injuries from the battlefield to the central hospital for brain-injured casualties in Berlin.

Today the German Armed Forces Medical Service is a separate service similar to the Army, Navy, and Air Force. All 5 German Armed Forces hospitals, which are located in Berlin, Koblenz, Hamburg, Ulm, and Westerstede, have neurosurgical departments and are fully integrated into the German health care system for the civilian population. At present, there are 12 neurosurgeons in the German Armed Forces. The Department of Neurosurgery at the German Armed Forces Hospital in Ulm plays a leading role in German military neurosurgery and is the only neurosurgical department that provides full-scope residency training in neurosurgery. The German Armed Forces Hospital in Ulm is a tertiary care hospital and has a center for head and neck medicine and surgery. A rescue helicopter is stationed at the hospital in Ulm, which provides the services of a Level I trauma center.

After World War II, neurosurgeons of the German Armed Forces were deployed abroad for the first time from 1995 to 1997 in Rajlovac and then from 1997 to 1999 in Trogir when they took part in the United Nations Protection Force (UNPROFOR) and Implementation Force (IFOR) missions (in the former Yugoslavia). During these deployments, it became clear that the German Armed Forces Medical Service did not require the on-site presence of a neurosurgeon to perform its tasks for the Implementation Force and/or Stabilization Force missions. For this reason, neurosurgeons were no longer deployed to the former Yugoslavia after December 1999. On account of the operational spectrum of the German Armed Forces, there was no situation in which a German soldier required on-site neurosurgical treatment. This was also the beginning of the successful use of military telemedicine. Since that time, neurotrauma courses for German Armed Forces surgeons and orthopedists have been conducted and are still being optimized. It is not the objective of these courses to qualify surgeons as neurosurgeons in a brief period of time. If patients undergo surgery performed by surgeons who overestimate their abili-
ties in the field of neurosurgery, the consequences could be devastating. Rather, the objective of the course is to give surgeons and orthopedists the knowledge and skills they need to provide simple acute care for patients who are in a life-threatening situation. Surgeons must accept that they can only provide initial care—similar to damage control surgery—and that patients must be repatriated to their home country for definitive care. Another no less important objective of the course is to make participants understand when no intervention is indicated and when they must simply wait for the repatriation of a patient. At the same time, surgeons and orthopedists can expect to gain the practical skills and theoretical knowledge they need to provide initial surgical treatment for patients with a traumatic brain injury and/or spinal trauma. Surgical skills are practiced above all on pig and human cadavers in the Department of Anatomy at the University of Ulm.

Recent years have shown that teleconsultation and repatriation are particularly effective when the specialist at home and the nonspecialist in the country of deployment know each other personally and when they share relevant theoretical knowledge. In the past, former course participants successfully managed several patients with (open) traumatic brain injuries in the country of deployment.

The ISAF Mission

The question of whether a German contingent that is involved in operations abroad should include a neurosurgeon was not raised again until the beginning of the ISAF mission. Until the summer of 2007, patients with neurotrauma had been treated by surgeons who had completed a neurotrauma course and had received training in a neurosurgery department. Since July 2007, neurosurgical services have been continuously available in the German (Role 3) field hospital (Table 1 and Figs. 1–3) in Mazar-e-Sharif, Afghanistan, and have been provided by neurosurgical specialists from the German Armed Forces and neurosurgeons from the French Army. As a result of this cooperation with the French Army, a pool of approximately 10–15 neurosurgeons ensures the availability of neurosurgical services and the provision of primary care for patients with all types of neurotrauma in the field hospital.

Camp Marmal is located outside of Mazar-e-Sharif in northern Afghanistan, 450 km north of Kabul. It previously housed Dutch forces and was taken over by the German Armed Forces in November 2005. Since then the camp has expanded and now covers an area of $1000 \times 2000$ m. It includes a field hospital with a size of $4000$ m², which was completed in 2007. The hospital is located in fixed buildings, and it is managed by a hospital company. Apart from laboratories for clinical chemistry, transfusion medicine, microbiology, veterinary medicine, and food chemistry, the field hospital houses a pharmacy, an emergency unit with 2 resuscitation rooms, a radiological department with a state-of-the-art CT scanner, a surgical unit with 2 operating rooms and a recovery room, which can be used as an extended intensive care unit in a mass casualty situation, as well as an outpatient unit, a modern intensive care unit, and inpatient wards. In the field hospital of Mazar-e-Sharif, patients can receive medical and surgical care not only from a neurosurgeon but also from an internist, a urologist, an otolaryngologist, a dermatologist, a neurologist, a psychiatrist, and a dentist (oral surgeon). Veterinary support is available as well. In addition, the field hospital has a telemedicine system that allows on-site medical professionals to receive support in special cases as well as interdisciplinary advice from remote specialists.

TABLE 1: North Atlantic Treaty Organization levels of medical support

<table>
<thead>
<tr>
<th>Role</th>
<th>Location</th>
<th>Level of Care</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>mobile aid stations</td>
<td>emergency medical care, stabilization for transportation</td>
</tr>
<tr>
<td>2</td>
<td>mobile surgical hospitals</td>
<td>initial op</td>
</tr>
<tr>
<td>3</td>
<td>field hospitals</td>
<td>further surgical care, acute clinical care</td>
</tr>
<tr>
<td>4</td>
<td>hospitals</td>
<td>definitive care, rehabilitation</td>
</tr>
</tbody>
</table>

Camp Marmal is located outside of Mazar-e-Sharif in northern Afghanistan, 450 km north of Kabul. It previously housed Dutch forces and was taken over by the German Armed Forces in November 2005. Since then the
surgery can be performed from the craniocervical junction down to the lumbosacral spine. If required, spinal stabilization by instrumentation is also possible. All necessary instruments as well as halo fixation devices for cervical immobilization and instruments for the management of peripheral nerve lesions are available in the field hospital of Mazar-e-Sharif. In addition, a surgical microscope and mobile radiography units can be used for neurosurgical procedures.

If capacities are available, German medical personnel also provide medical and surgical care to local patients including members of the Afghan National Army and Police, Afghan civilians, and members of governmental and nongovernmental organizations. For example, one of these cases was a 25-year-old patient with a lower leg fracture. The presence of hemiparesis was noted during the initial examination (see Fig. 5). Cranial CT scanning demonstrated a depressed fracture in the central region (see Fig. 6). The Afghan physician who had provided initial care had treated this injury with only a few sutures, which were largely obscured by the patient’s hair. After the cranial CT scan, the patient underwent surgery. The hemiparesis improved, leaving only a minimal residual deficit. The postoperative course was otherwise unremarkable. The majority of patients, however, are ISAF members stationed at Regional Command North locations.

Between July 2007 and December 2009, a total of 140 neurosurgical procedures were performed in the field hospital. Sixty-four surgeries were performed for cranial or spinal neurotrauma management (Fig. 4). During the entire period, only 10 ISAF members required acute or urgent neurosurgical interventions. Five of these 10 patients underwent neurosurgical treatment during the last 3 months of 2009. Spinal injuries occurred not only in the cervical but also in the thoracic and lumbar spine. Cervical injuries were managed using iliac crest bone grafting and ventral plate fixation. The ISAF members with thoracic and lumbar spine injuries underwent only dorsal instrumentation and decompression. Definitive ventral treatment was provided by a hospital in the home country. Afghan patients also received ventral treatment involving the placement of interposition grafts (iliac crest bone grafts, rib grafts, or spineoplasty) in the field hospital. Local patients also underwent elective surgical procedures for disc herniation, trigeminal neuralgia, entrapment neuropathy, and other conditions.

Until October 2009, no German soldier had ever required acute neurosurgical care during a military deployment. In November 2009, however, a German soldier underwent an acute neurosurgical intervention for the first time in German history after World War II. This soldier developed an epidural hematoma after having been injured in an attack on a military vehicle.

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Afghan National Army and Police and 115 local patients underwent neurosurgery. Sixty-two procedures were carried out under acute or urgent conditions and 78 operations were elective.

The Way Ahead

Major efforts in the near future will focus on centralizing the neurosurgical management of patients in Afghanistan. The objective is to deploy alternately a German and a French neurosurgeon in the newly established French-led field hospital at Kabul International Airport. Reliable casualty evacuation must, of course, be ensured. Should the central deployment of neurosurgical specialists prove successful, other specialist services—for example, vascular surgery, gynecology, or urology—may be centralized in a similar manner.

Since an increasing number of deployments and an increasing “robustness” of mandates are expected, the limited availability of specialist personnel and the wish to provide neurosurgical expertise in as large an area as possible require the optimization of personnel deployment using state-of-the-art information technology and telemedicine. Teleconsultation and even teleteaching facilities are available and in regular use. The provision of services such as teleassistance, telementoring, and telerobotics requires considerable infrastructural resources not only in the home country but even more so in military operational environments abroad. Working groups of the European Space Agency are currently attempting to establish complex telematic networks in a multinational setting (including German Armed Forces neurosurgical departments). A system that has proven to be effective in clinical practice and can also meet military operational requirements is not yet available. The long-term objective is to support on-site medical personnel and remote military specialists in neurosurgery who provide advice (teleconsultation) or actively help perform neurosurgical interventions (teleassistance). Teleassistance involves the use of a camera that allows a remote specialist to directly support a surgeon intraoperatively. One major problem is the establishment of an adequate telecommunications infrastructure that ensures live interaction between the patient, the on-site surgeon, and the remote neurosurgeon. Available systems are not yet able to transmit the large amounts of data required for this purpose. For this reason, existing surgical planning and support systems that are based on information technology must be continuously improved and extended at home. Once they have been integrated into everyday clinical practice, these systems (or at least basic components) can be transferred to field hospitals in countries of deployment. As these systems are used in everyday practice and for training purposes and their performance is continually monitored and assessed, they are already being integrated into future deployment concepts.

The definitive treatment of complex head and spinal injuries requires a high level and wide variety of resources that cannot be held available in countries of deployment. For this reason, definitive treatment must be provided in a German Armed Forces hospital in Germany (Role 4). This applies to the ventral treatment of thoracolumbar spine injuries and severe head injuries such as a cranio-plasty after osteoclastic trepanation or facial nerve reconstruction. This means that medical health professionals in the hospitals of the German Armed Forces must have state-of-the-art equipment and all the knowledge they need to provide optimal definitive treatment.

The Role of Neurosurgery at Home

Modern neurosurgery that is based on and reflects current knowledge and advances requires the availability of state-of-the-art technical equipment. Only then can a
hospital ensure maximum patient safety and maintain a competitive position in the hospital market. The neurosurgical departments of the German Armed Forces hospitals must be able to compete with their civilian counterparts. Whether neurosurgical patients who present with conditions or require procedures that may be of relevance in military operational settings will be treated in a specific neurological department depends on the availability of modern surgical support procedures. Frame-based and frameless stereotactic surgery and neuronavigation have been used for years. The integration of functional imaging, for example, PET, functional MR imaging, and fiber tracking, into a navigation system are likely to become standard for certain types of surgeries in the future. In addition, 5-aminolevulinic acid–induced fluorescence is used for intraoperative guidance of malignant glioma resection. Microscope-integrated indocyanine green angiography is also used during cerebrovascular procedures on a regular basis. For more complex spinal surgery (above all spinal fusion and cervical spine or craniocervical junction fixation), a navigation system is almost always used and enables the surgeon to correctly place the screws. All these modern methods are being used at the Department of Neurosurgery of the German Armed Forces Hospital in Ulm as well as in the other neurosurgical departments operated by the German Armed Forces. Military hospitals must remain competitive with civilian hospitals to ensure the continued availability of a sufficient number of patients requiring intracranial and spinal procedures that are likely to be of relevance in military operational settings and thus to ensure the initial and sustainment training of neurosurgical professionals. In this context, the importance of CT and MR imaging techniques for intraoperative diagnosis should be emphasized. Particular attention must be paid to the clinical application and the further development of these techniques.

**Conclusions**

After World War II, there was no compelling need for the presence of military neurosurgeons in military operational settings abroad. As a result of the limited availability of civilian neurosurgeons in most countries of deployment, however, neurological treatment is an important—and sometimes even expected—component of the medical care that is offered for the local population and local personnel, provided such care is part of the mission of the medical service.

**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: UM Mauer. Acquisition of data: UM Mauer, C Schulz, R Rothe. Analysis and interpretation of data: UM Mauer, C Schulz, R Rothe. Drafting the article: UM Mauer. Critically revising the article: U Kunz. Reviewed final version of the manuscript and approved it for submission: U Kunz. Administrative/technical/material support: UM Mauer, U Kunz.