Centrifuge "Therapy" for Psychiatric Patients in Germany in the Early 1800s

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In 1818, Dr. Ernst Horn (1774–1848) reported miraculous cures for patients suffering from hysteria through the use of centrifuges at the psychiatric wards of the Charité-Hospital in Berlin during the previous decade. In his book, "Public Account Concerning My 12 years' Service as Second Physician of the Royal Hospital in Berlin, Including Experiences from Hospitals and Mental Institutions," a full description of the indications and methods for treatment of mental illness, including technical data and construction costs for a rotating bed and rotating chair, is given. The rotating bed was turned by a crankshaft connected by ropes to a capstan. Slowing or stopping was achieved by tensing a rope around a wheel near the ceiling. With a diameter of 13 ft, this therapeutic instrument was capable of producing up to 4 to 5 $-G_z$ in the head region. Several hundred patients and many volunteer subjects, including medical doctors, were reported to have been exposed to the rotating devices, along with some miraculous cures. Apart from the ethical problems associated with this type of torturous treatment, the rotating bed could be described as an ancient centrifuge. With the well-documented observations made on this device, the very first description of G-induced biomedical effects, such as shortness of breath and a feeling of oppression and anxiety, was given: These observations were comparable to those made one century later on human centrifuges and in flight.

Keywords: aerospace medicine, centrifuge, rotating bed, rotating chair, medical ethics, Ernst Horn, Germany, history.

HUMAN CENTRIFUGES have been used in aviation medical research since the early 1930s. They have been of great value for flight safety issues and aerospace medical research, and are also currently used for pilot selection and physiological training. It is surprising, however, that 19th-century human centrifuges were also used in medical therapy, such as in the following example of psychiatric patients in Berlin, where several hundred patients were exposed to high negative Gs ($-G_z$) for therapeutic reasons (1,2). In 1818, Professor of Medicine Ernst Horn (a later General of the Prussian Medical Corps with a comparable civilian rank of a Geheim-Medicinalrath) (1774–1848), published his 333-page book "Public Account Concerning My 12 years' Service as Second Physician of the Royal Hospital in Berlin, Including Experiences from Hospitals and Mental Institutions" (3).

The mental institution in Berlin was originally an estate belonging to a psychiatric patient who died in 1718 without an heir. His home was donated to a Berlin "charity fund," which arranged for it to become a psychiatric hospital (Institute for Mental Illness, Epileptics, but also Poor and Infirm, as well as "wanton, lazy and loafing persons"). In 1798 this psychiatric hospital in Krausestreet was destroyed by fire and a number of the ill were picked up by the Charité-Hospital. Between 1785 and 1800 the largest psychiatric ward in Germany was built there (Department for the Insane and Mad). At this time in 1808, Ernst Horn was designated as the first professor of psychiatry in Germany. He built his reputation as a pioneering clinical psychiatrist at the Charité Psychiatric Ward.

Although Horn and his colleague Griesinger regarded mental illness as having a somatic etiology, he advocated the use of active force along with the methods of the so-called "order therapy" to "treat" his patients. He was forced to leave his assignment after being held responsible for the death of a female patient caused by putting her into a sack in order to calm her down (6). Another way patients were mistreated at his hospital from today's perspective was by use of a rotating bed (Drehbett), and later a rotating chair (Drehstuhl). Horn described the use of both in his book after these rotating machines had been used for many years on several hundred patients with the intent to "treat" and "cure" them. This method seems not to have been his own idea, as Dr. Joseph Mason Cox (1763–1818) had already published his book, "Practical Observations in Insanity," in 1804, and it was translated into German in 1811. However, Erasmus Darwin is regarded as being the first to have reported the effects of human centrifugation in 1795, and hinted at its therapeutic use as well (5).

The German rotating bed was first constructed in about 1808 by the carpenter Richter senior, with the rotating chair following just a few years later—it was built by a patient through instructions by his doctors. The base of the bed was almost 13 ft long and had a width at the head of 3 ft. It was turned by a crankshaft that was connected by ropes to a capstan and was operated by men. Slowing or stopping was achieved by

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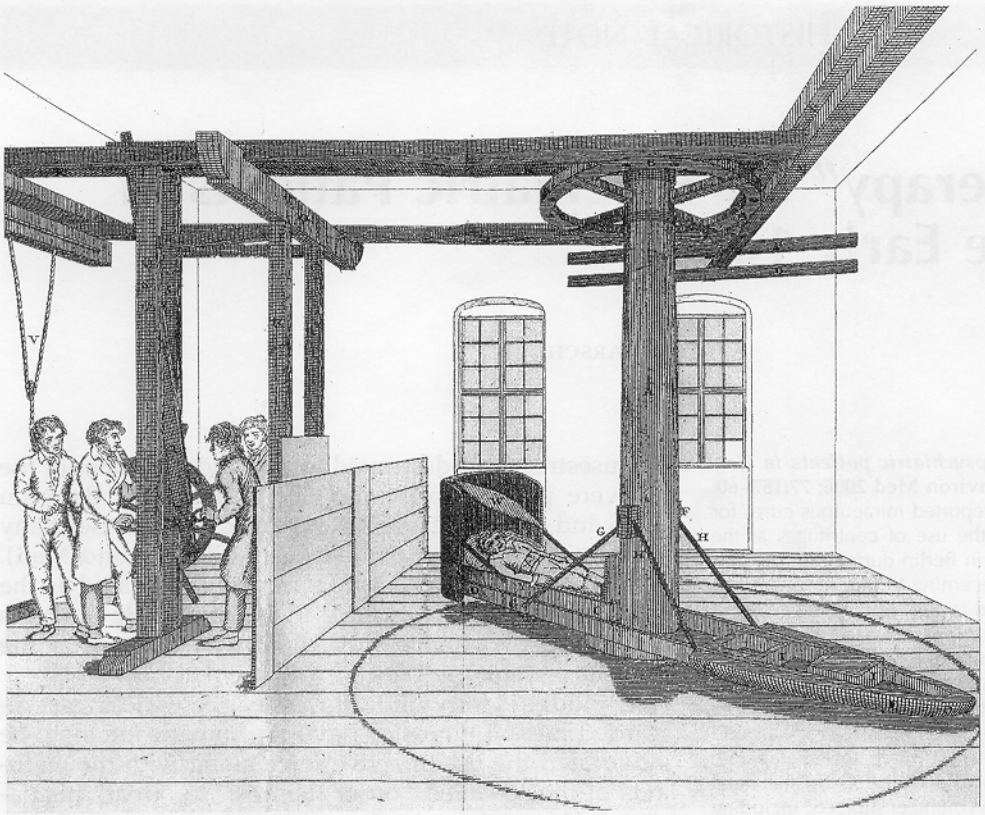

Fig. 1. Antique centrifuge (3) for the treatment of mental disease. A patient in the negative G position could be exposed up to 4 to 5 G ($-G_z$).

tensing a rope around a wheel near the ceiling. With a diameter of 13 ft, this therapeutic instrument was capable of producing up to 4 to 5 $-G_z$ in the head region (**Fig.1**).

The patients were brought seated or supine with the head in the outward position. There are no indications that it was used as a double arm centrifuge to expose a second patient simultaneously. The patients were exposed to extremely unpleasant centrifugal forces for only a couple of minutes. The centrifugal arm was rotated up to 60 to 120 rpm with a slow onset. For the supine patient, this produced a negative G force of -4 to -5 G_z in the head region, which was not well-tolerated.

In addition to the patients, some volunteers, including doctors, subjected themselves to centrifugal forces on the machines. They experienced the following subjective sensations: shortness of breath, feelings of oppression, anxiety, difficulty speaking, feelings of being stretched headwards, fear of being catapulted by the vibrations, and an unpleasant feeling of an odd emptiness of the head. These symptoms were of vestibular and cardiovascular origin caused by exposure to $-G_z$, as we now know.

The centrifuged subjects initially showed an increased redness in the face, which then turned pale during the spinning. Many of them complained of dizziness and nausea, and in some cases, vomiting. When the machine was stopped, vertigo was immediately experienced, which was feared by the patients.

Generally speaking, those who were exposed to this treatment experienced the ride as highly troublesome and unpleasant. The patients requested an immediate halt to the procedure and refused to continue. Conjunctival hemorrhage was an observed objective effect of $-G_z$, but was regarded as of no major concern since it disappeared within a few days. Significant cardiopulmonary effects were not observed. Spinning at 90–100 rpm did not increase the pulse in every case, but for some, it did increase slightly (1–4 bpm). The subjects experienced labored breathing and vaguely described sensations in the breast and abdomen, as well as the sensation of increased body temperature. Indeed, when oral temperature was taken after spinning with a type of thermometer called a Réaumursch, an increase of 1–4°C was noticed. It remains unclear whether these documented changes were due to improper methodology, e.g., an original under-measurement (common in oral temperature) with a noted rise affected by increased blood flow.

The normal duration of spinning was 60 to 90 s, since subjecting the patients to prolonged spinning for 1.5 to 2 min was not well-tolerated. The individuals were able to request cessation of the unpleasant experience only by groaning and screaming. Even healthy volunteers (some of them medical doctors) who tried to withstand the procedure as long as possible could tolerate it only for a maximum duration of 2 to 3 min. Most requested to stop within the first 2 min. Dr. Horn assumed that the patients were less sensitive than the volunteers. Some of them did not express discomfort in any way, or perhaps they could not address it.

The therapist's intention was to apply a very unpleasant, initially unfamiliar sensation to the patient. Thereafter, the fear of repeated spinning was expected to be of therapeutic value as well (indirect psychiatric rem-

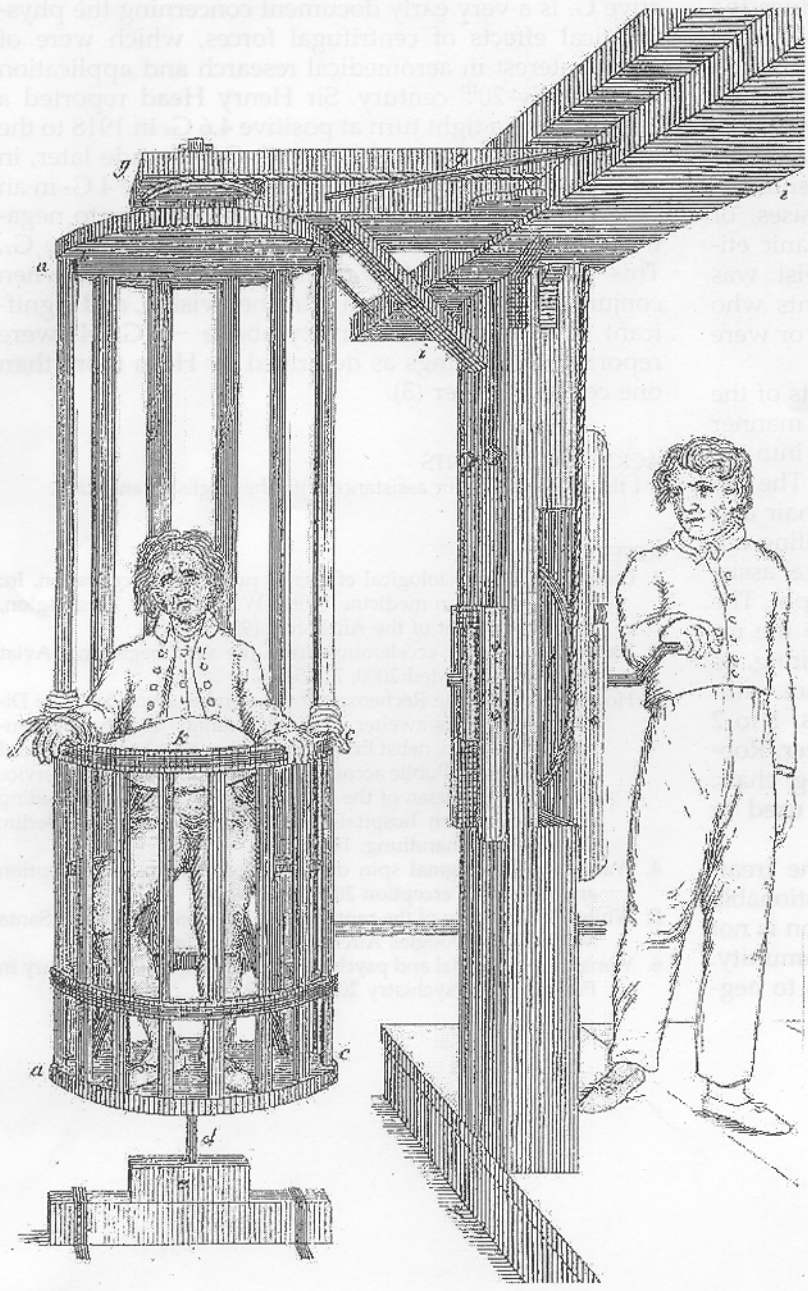

Fig. 2. Antique rotating chair (3) for the treatment of mental disease.

edy). It is remarkable that the centrifugation effects were expected to have a positive outcome on such a broad variety of diagnoses. Ethical problems were not recognized by the doctors at all. As Horn said in 1818: "The greater the susceptibility of the patient, the less he has become accustomed to the treatment, the more lively his intimidation toward the apparatus, the more uncomfortable and onerous the application, the more charitable the effects of the therapy."

Indications for this harsh treatment were, for example, acute episodes of "raving madness" (delirium?) and mania, the symptoms of which could be terminated by this treatment. Furthermore, patients with intractable melancholy and who were non-compliant could be brought to "order" and obedience by the use of the rotating bed. This treatment also seemed to be indicated for psychotic suicidal patients. The therapy seemed to affect behavioral change, as patients were reported to become charitable, shaken, and in a changed mood. Patients who refused any food with the intention to starve changed their mind after being spun because they feared being placed on the machine again more than dying of hunger. Other mentally ill patients, who were mainly quiet, passive, and refused to work, changed their behavior after the G exposure, "woke up," and became more excited. Therefore, the order-therapy was regarded as being useful in changing patients' attitudes towards compliancy with the rules and regulations of the institute. Epileptic patients were mostly "calmed down" by the centrifugation.

However, the repeated use of the rotating bed was regarded as being of no additional value, as the apparent positive effects seemed to disappear with repetition due to adaptation. In many cases the threat of again

being exposed to the machine seemed to produce the desired effects. No therapeutic effects were expected in patients who were either indolent or sadomasochistic. It was also not to be used on those who were fearful, paranoid, hypochondriacs, or fragile, or on patients curable by less stressful methods. Additionally, it was not recommended that those patients who had suffered for a long time with additional organic diseases, or those whose mental illness was due to an organic etiology, be exposed to spinning. The therapist was warned to be cautious, especially with patients who had a history of apoplexy, digestive problems, or were otherwise in poor health.

After having described the use and the effects of the rotating bed, Dr. Horn described in a shorter manner the use of the rotating chair. It was introduced into the hospitals' repertoire some years after the bed. The patient's head and hands were fastened to the chair and he was additionally secured to prevent him falling out during rotation, as shown in **Fig. 2**. One medical assistant was able to rotate the device at 60 to 125 rpm. The patients experienced comparable sensations to the rotating bed, such as vertigo, nausea, and vomiting, as soon as 30 s after initiation. Volunteers could not withstand the exposure much longer than patients, 1 to 2 min being the maximum time tolerated (3). Later, Robert Bárány (1876–1936) modified the rotating chair. Now called the Bárány chair, it was widely used in early aviation selection process.

Aside from the medical ethics involving the treatment of mentally ill patients with such questionable experiments, it is of interest that this publication is not widely known in the aerospace medical community. The described procedure for exposing persons to negative G_z is a very early document concerning the physiological effects of centrifugal forces, which were of major interest in aeromedical research and application in the early 20th century. Sir Henry Head reported a pilot making a tight turn at positive 4.6 G_z in 1918 to the British Medical Research Council. One decade later, in 1929, Lt. A. Williams, USN, reported negative 4 G_z in an inverted loop, and expected human tolerance to negative Gs to be significantly lower than for positive G_z. This was experimentally confirmed 25 yr later, when conjunctive hemorrhage, diminished vision, and significant slowing of heart activity above -3 G_z (4) were reported, all findings as described by Horn more than one century earlier (3).

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