

St Hugh's Military Hospital (Head Injuries), Oxford 1940–1945

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Despite being open for only five years, St Hugh's Military Hospital (Head Injuries) has a seminal place in the history of neurology, neurosurgery and rehabilitation medicine. At its peak, during the Normandy campaign of 1944, it provided 430 beds for the treatment of service personnel. Between 1940 and 1945, 13,000 patients were referred to St Hugh's providing a unique opportunity for ground-breaking research into the

management of head injuries. The doctors at St Hugh's collaborated with research scientists at Oxford University in many areas of fundamental research including the treatment of infection, the mechanics of brain injury, brain surgery, neuropsychiatry and rehabilitation, and the use of electroencephalograms. This paper documents these scientific advances and considers their influence on the practice of neurology and neurosurgery in the UK.

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Introduction

St Hugh's Military Hospital (Head Injuries), Oxford, played an important role in the history of neurology, neurosurgery and rehabilitation medicine. Between 1940 and 1945, 13,000 patients were referred to St Hugh's and, as the only neurological hospital in England during the Second World War, it became the training ground for many neurosurgeons and neurologists of the post-war era.

Several authors have written about St Hugh's when describing Hugh Cairns, an Australian neurosurgeon, his associates and the development of neurosurgery during the Second World War.^{1–5} They concentrated on the surgical aspect of treatment at St Hugh's. Trevor Hughes documented Cairns' innovative mobile neurosurgical units (MNSUs) and his research on motorcycle accidents which led to the use of protective crash helmets. Less documented is the context in which the doctors at St Hugh's collaborated with research scientists at Oxford University in many areas of fundamental research, including the treatment of infection, the mechanics of brain injury, brain surgery, neuropsychiatry and rehabilitation, and the use of electroencephalograms (EEGs).

All the MNSUs' neurologists and neurosurgeons were trained at St Hugh's and many medical staff of the National Hospital for Nervous Diseases (hereon referred to as Queen Square) followed Cairns to Oxford, including the neurologists Derek Denny-Brown and Charles Symonds. The unit was run on a completely different model to the voluntary or the Emergency

Medical Services (EMS) hospitals discussed below. The neurologists and neurosurgeons were in sole charge, with Cairns at the helm; St Hugh's was described by Symonds as 'Cairn's hospital'. The consultants were full-time. St Hugh's became the only unit where neuropathology was carried out after Maida Vale Hospital for Nervous Diseases, Queen Square and the West End Hospital for Neurological Diseases closed down as a result of bombings.

Cairns recognised the value and proximity of Oxford University's excellent departments ancillary to clinical study as an ideal environment for the advancement of medical knowledge and St Hugh's derived benefit from its close association with Oxford University. For more than 800 years Oxford has made a remarkable contribution to the art and science of medicine. Scientists, philosophers and physicians made the city an outstanding scientific centre, attracting innovative and creative scientists from all over the world. In the 1940s and 1950s, sometimes described as 'the golden years', Oxford was a hub of scientific discovery with fundamental research in the science departments across the city leading to innovations such as the first effective treatment of bacterial infection in the form of penicillin, the first treatment for haemophilia using anti-haemophilic globulin, the discovery of X-ray crystallography and ground breaking research into the biochemistry of nerve cell regeneration.

Roger Gilliatt, the first professor of neurology at Queen Square, stated that trainees in neurology should be in a

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position to take a problem identified during the course of their day to day care to the laboratory where it could be investigated rigorously. This is precisely what took place at St Hugh's. Instead of working in isolation to address the clinical problems they encountered, they collaborated with research departments to carry out fundamental research and develop solutions.

Historical background – medical provision in the UK and the treatment of head injuries

During the First World War, 15% of all cases treated at first-aid posts suffered from head injuries and 50% of those who died had been shot in the head or neck.⁶ Initially, there was no segregation of patients and no neurosurgeons, but towards the close of the War, patients with head injuries were congregated at Étaples and Wimereux under the care of Geoffrey Jefferson and in a base hospital under the direction of Harvey Cushing. With the exception of Percy Sargent and Cushing, none of the general surgeons had any prior experience of brain surgery. Infection was the greatest concern and wounds with dural penetration resulted in a mortality rate of 40%.⁶

The state of neurology and neurosurgery in England between the wars

There were no neurological units in the London voluntary hospitals. They relied on part-time honorary visiting neurologists who, despite being listed on the staff, visited sporadically. Three London hospitals were dedicated to the care of patients with neurological diseases: Maida Vale Hospital for Nervous Diseases, Queen Square and the West End Hospital for Neurological Diseases. Doctors at Queen Square did not contribute to the rapid developments taking place in neurology as, despite the very high standard of clinical practice, there was little commitment to laboratory research.⁷

Advances in neurosurgery were equally slow. Cairns, a general surgeon at the London Hospital, had trained under Cushing to become a neurosurgeon (Figure 1). He was determined to establish neurosurgery as a specialised field but the consultants at the voluntary hospitals were opposed to specialisation, believing that medical students should be taught by general physicians and surgeons. Cairns waited seven years to be appointed the first neurosurgeon at the London Hospital but he was not provided with an independent functioning unit and earned his living from private practice in nursing homes. He also held appointments as neurosurgeon to Maida Vale and Queen Square where he only performed a single operation as senior neurologists would not grant him admission rights. Cairns and Jefferson were the only consultant neurosurgeons in England, with Jefferson coming to London from Manchester to operate once a week. In 1937, Cairns was appointed the first Nuffield Professor of Surgery after Lord Nuffield, a visionary philanthropist, endowed the Oxford Medical School to make it a centre for research,

Figure 1 Sir Hugh Cairns (1896-1952) Reproduced by kind permission of the Wellcome Library, London



teaching and clinical expertise. His purpose was to address the need for specialist treatment with professors trained in medicine, surgery, obstetrics, orthopaedics and anaesthetics, each with his own department with full responsibility for the clinical care. Oxford, with its outstanding research tradition and facilities, particularly in the anatomy, physiology and zoology departments, provided a beacon of hope for academic medicine in the UK, divorced from the London voluntary hospital system.

The setting up of the Emergency Medical Services (EMS) hospitals

With the rise of Nazi Germany, war in Europe became inevitable. Provision was made to look after the anticipated casualties and after the experiences of the First World War, it was recognised that specialised units were required to treat specific injuries such as head and peripheral nerve injuries.

Until 1938, local authorities had been responsible for the provision of Casualty Clearing Hospitals in the event of war. The cost of providing base hospitals was to be borne solely by the Exchequer. At the beginning of June 1938, the Ministry of Health assumed responsibility for the organisation of the EMS in preparation for air raid casualties. Rather than monopolising existing military hospitals, huddled EMS hospitals were erected for the treatment of civilian and service casualties with the understanding that if fighting became intense, priority would be assigned to injured servicemen.⁸ This proposal had the merit of keeping medical and nursing personnel fully employed. In practice, they treated both civilians and service casualties. The establishment of the EMS can be seen as the forerunner of the National Health Service.

In 1938, Cairns, who was already neurosurgeon to the Army, became the neurosurgical adviser to the EMS. EMS specialist centres for the treatment of head injuries in civilians and military personnel were established across the country, ten in England and two in Scotland, but there were no neurologists attached to the EMS hospitals. Staff consisted of a neurosurgeon, a chief assistant, two house surgeons, an anaesthetist, a general pathologist and an electroencephalographer. These centres, which varied in size from 60–80 beds, came into being over a period of time stretching up to 1944 during the planned invasion of Europe.

Specialist units for the treatment of war casualties

With its proximity to London, Oxford was chosen as the ideal site for the establishment of a series of specialist units responsible for all aspects of care as well as research into diagnosis and treatment. Gathorne R Girdlestone, Professor of Orthopaedics, set up an orthopaedic unit, Herbert J Seddon, Professor of Orthopaedic Surgery, was in charge of a peripheral nerve injury unit at the Wingfield Morris EMS Hospital, and Cairns and Symonds, with the assistance of Farquhar Buzzard and George Riddoch, set up a head injury unit at St Hugh's College.

St Hugh's Military Hospital (Head Injuries)

Cairns, a superb administrator, had initially planned to site the head injury unit at the Radcliffe Infirmary exclusively for the treatment of Army personnel, but by 1938, he and Symonds had settled on St Hugh's, a bigger more suitable venue where all service personnel could be treated. An all-female College, St Hugh's, with its modern architecture, long corridors and few narrow staircases, was better suited to transformation into a hospital than older colleges. (See Figures 2 and 3) Most of the College inhabitants had left and it was hoped that Oxford would be spared from bombing, which proved correct.

The hospital opened in February 1940 with 50 beds, soon increasing to 300 when further accommodation was built in the central part of the College in the form of prefabricated huts, reaching 430 beds at the height of the Battle of Normandy. The primary aim was to return servicemen to active service and, as the first hospital to offer occupational therapy and rehabilitation at two nearby Red Cross convalescent centres, they achieved a high rate of return to duty.³

Staffing

Cairns carried out neurosurgery at the nearby Radcliffe Infirmary supported by Joseph Pennybacker and several neurosurgeons trained by Cushing and himself: Cecil Calvert, Douglas William Claridge Northfield, William Henderson and Peter Ascroft. Symonds, consultant neurologist to the Royal Air Force, appointed the neurologists, initially Denny-Brown and William Ritchie Russell. Dorothy Russell, neuropathologist at the London Hospital, had trained in America and transferred to Oxford, bringing all her equipment with her. Despite not being given a commission in the Army, she worked at the Radcliffe Infirmary but was stationed at St Hugh's where she carried out all the neuropathology on servicemen while Pio

Figure 2 St Hugh's College, Oxford. Personal photograph 2016



Figure 3 Christmas party for patients in St Hugh's College Dining Hall Oxford during WWII. Reproduced by kind permission of St Hugh's College archives



Del Rio Hortega provided the neuropathology services for the civilian population.

The hospital benefited from full-time neurologists, neurosurgeons, ophthalmologists, dental surgeons, psychiatrists, psychologists, speech therapists, physiotherapists and masseurs. Cairns was based at St Hugh's and this arrangement had the inestimable benefit of keeping him in constant touch with the patients, the university research departments and the neurological trainees. He carried out weekly rounds on the surgical wards and provided surgical advice for medical cases. Furthermore, the staff at St Hugh's could call on the resources of Cairn's neurosurgical department at the Radcliffe Infirmary. At all levels there was the closest cooperation between neurologists and neurosurgeons.

The doctors were selected because of their particular interest in head injuries and their previous experience in the field. Cairns, inspired by Cushing, strived to establish neurosurgery as an independent speciality. In 1935 he was called to attend TE Lawrence (Lawrence of Arabia) after he suffered a head injury in a motorcycle accident. Despite Cairns' efforts, he died shortly afterwards, having suffered a fatal skull fracture.

Deeply affected by this tragedy, Cairns realised that a helmet might have saved Lawrence's life. At the outset of his career, Symonds received training in psychiatry and between the Wars he developed his interest in head injuries at Guy's Hospital where he insisted on seeing all such cases on admission. There he performed lumbar punctures and published extensively on head injuries. Denis Williams had trained on the use of EEGs in the USA before the War and brought the first EEG apparatus back to the UK. Ritchie Russell was deemed eminently suitable by Symonds having submitted his MD on *Brain damage following head injuries* in 1932, followed by publication of his research on concussion, a subject which would become a lifelong interest.⁹

Cairns was a visionary and he addressed and adopted all of Cushing's principles of treatment for head injuries learned during the First World War. Cushing showed that if the patients were operated on within 24–48 hours, debridement carried out and the wound closed, mortality was reduced from 50% to 10%, but this required expert neurosurgery.¹⁰ Cairns addressed the need for expert neurosurgery on the battlefield by training neurosurgeons and neurologists at St Hugh's. Cushing had encountered difficulties transporting patients back to base hospitals with proper facilities for early treatment. To this end, Cairns saw the solution to the problem by bringing the surgery to the patients and he developed MNSUs which could be deployed close to the front line. Cushing had showed that managing infection of the head wounds was vital to success and Cairns encouraged research into the use of antibacterial therapy.

Early treatment: mobile neurosurgical units

Trevor Hughes has described Cairn's involvement in the setting up of MNSUs and therefore this is only briefly alluded to here with special reference to the hospital.^{2,11} Sepsis on the battlefield was far worse than anything experienced in civilian life because of the nature of the injuries with in-driven fragments of bone, dirt and bacteria. Cairns realised the value of despatching MNSUs to the battlefield. The MNSUs recorded a mortality of 10.8% (54/500 cases).¹² They were first deployed in France, North Africa and Italy, but came into their own in El Alamein in 1942 where they played a vital role through expert treatment followed by swift evacuation.² During the Normandy campaign in 1944, air evacuation allowed the wounded, including 142 cases of penetrating head injuries, to be taken directly from the battlefield to St Hugh's so that the hospital effectively operated as a MNSU. The recorded death rate was 6.4% (21/330 cases).¹³ These figures are not truly comparable as the patients transferred were less seriously injured, therefore a lower mortality would be expected. The transport of casualties directly to St Hugh's ceased when the Allied armies broke into Belgium and Holland and long lines of communication and poor roads made immediate evacuation from the battlefield impossible, so once again MNSUs were deployed to the front.

Figure 4 Professor H. Florey. Reproduced by kind permission of the Wellcome Library, London



Infection and antibiotic treatment

Infections due to penetrating wounds of the head were so prevalent at St Hugh's that much of the research focused on prevention. Mortality from streptococcal meningitis was greatly reduced with the advent of sulphonamides in 1937 but it was the development of penicillin and the finding by Florey and colleagues that it inhibited the growth of pneumococcus that led to the development of antibiotic treatment for meningitis (Figure 4). Cairns was a personal friend of Florey, a fellow Australian who was Professor of Pathology in Oxford. Cairns arranged with Leslie John Witts, Professor of Medicine, to carry out trials of penicillin therapy at the Radcliffe Infirmary. The War Office was so impressed with the results that Cairns and Florey were despatched to the Middle East to carry out trials on the battlefield.¹⁴ Penicillin became available at St Hugh's in April 1943 and it was there and in the MNSUs that much of the research into the use of penicillin for the treatment of meningitis was carried out by Cairns, ES Duthie, WS Lewin and Honor Smith.¹⁵ Full scale clinical trials into the modes of administration of penicillin were carried out at St Hugh's. They experimented on intrathecal administration by different routes; into the lateral ventricles or in the lumbar subarachnoid space using different dosages and concentrations. They made daily recordings of the presence of the pneumococci in ventricular and cerebrospinal fluid, analysis of the cerebrospinal fluid (leucocyte count, protein content, penicillin content, bacteriological cultures) and monitored the clinical condition of the patients. They described the treatment of 16 patients of whom 12 survived. They concluded that, at high concentrations, penicillin could be injected intravenously and soon appeared in the cerebrospinal fluid. They recommended the use of a combination of sulphonamides, administered by mouth, and penicillin.¹⁵

Rehabilitation

From the outset Cairns had the vision to realise the significance and implication that immediate operation on the damaged brain was only an episode in the treatment of a head injury and he encouraged other physicians to explore and carry out research on different aspects of head injury, e.g. concussion and rehabilitation.

It was a major advantage at St Hugh's that the same consultant who established the initial diagnosis on arrival and administered the treatment could follow up the patient's progress over an extended period and gather crucial information. Symonds, Denny-Brown and Ritchie Russell and others followed up cases at Headington Hall in Oxford, and provided meticulous documentation and long-term studies. Patients undergoing rehabilitation were transferred to two Red Cross units outside Oxford: Tusmore Park (for patients with severe brain damage), and Middleton Park (for patients with head injuries); Ritchie Russell visited every patient once a week (Figure 5). Patients benefited from occupational therapy, physiotherapy, workshops and visits to Stoke Mandeville Hospital to participate in sport. Dances and boat trips were all part of the treatment.

Denny-Brown, who was in charge of the neurological division, analysed 1,200 cases up to 1942, and suggested there were two possible causes to declare a patient unfit for duty; organic and psychoneurotic and very often a mixture of both. He made a detailed analysis of 400 cases and found 65% to be psychoneurotic, thereby justifying the need for psychiatrists and psychologists to provide the necessary cognitive rehabilitation.¹⁶

After the defeat of the Allied Armies in France in 1940, the only way the UK could maintain the war against Germany was through a strategic bombing campaign. Initially, this was limited but it evolved to raids of over 1,000 bombers. The German defences were formidable and this resulted in losses of bomber planes to such an extent that the air crew were unlikely to complete a tour of duty. The implications of this upon the air crew were considerable, leading to a lack of morale and unwillingness to fly.

Symonds and Williams' research into the stress of flying and its effect on human psychology was on the borderline between neurology and psychiatry. They maintained a lifelong commitment to this work and made significant contributions by writing eloquently on the subject. Because of their experience in this field, Symonds and Williams were requested by the Air Ministry to investigate the psychological stresses experienced by aircrew when flying in the face of the enemy. They recognised fear and its consequences and distinguished between neurosis, which was a medical condition, and lack of moral fibre, which was a matter for discipline by the service personnel. In this way, unjust punishment was avoided and there was no escape through the medical 'back door.'¹⁷ Neuropsychiatrists who went into the field interviewed aircrew, recording their medical history on a card which was sent to St Hugh's to be documented and analysed. If appropriate, aircrew were admitted to St Hugh's for further investigation.¹⁸

There were many cases of serious trauma with persistent residual sequelae. During and after the Second World War, over 1,100 cases of missile wound of the brain were studied in detail at St Hugh's, including over 250 patients rendered aphasic by injury.¹⁹ This unique material provided

Figure 5 Ritchie Russell Consultant Neurologist. Reproduced by kind permission of the Wellcome Library, London



an opportunity to study many anatomical features of aphasia, including those cases in which one aspect of language function was affected more than others. The problems of cerebral dominance in right and left-handers were fully explored while the relationships between speech and mental disorders, such as amnesia, lead to a discussion on the many facets of cerebral activity.

In 1945, when Oxford University pressed for a return of the St Hugh's College premises, the hospital moved temporarily to the Churchill Hospital at Headington in Oxford, and then permanently to Wheatley (a short drive from Oxford) in 1946. This military hospital was a highly specialised institution where servicemen from all over the world were treated in five distinct units: neurosurgical, neurological, tubercular meningitis, general surgery and general medicine. Wheatley had an outstanding reputation and doctors doing their national service strove to be posted there. Ritchie Russell maintained a lifelong interest in head injuries and brought his team, CW Whitty, H Smith and Freda Newcombe, to Stoke Mandeville Hospital. He followed up the patients meticulously, both at the Churchill Hospital and Stoke Mandeville and, with his registrar Michael Espir, published on the subject. Grateful and loyal veterans willingly participated in ongoing research after the War to assess the neurological and psychological effects of their injuries, even donating their brains so that post mortems could be carried out. This work had been initiated by Ritchie Russell and Freda Newcombe, and continued until the latter's death in 2001.²⁰

Electroencephalograms (EEG)

EEGs initially provided a research tool but Williams started using the procedure for diagnostic purposes. In his presentation to the neurological section of the Royal Society of Medicine in 1941, he described how head injuries were notorious for their variable outcome and difficult prognosis. The advent of war and the concentration of 600 cases of head injuries at St Hugh's provided him with a unique opportunity to study the relationship between injury, clinical observations and the consequent changes in cerebral electrical activity through the use of EEG. Williams correlated the readings with different symptoms such as impairment of consciousness, coma, semi coma and confusion. In a 1941 study of 74

patients, he found a positive relationship between the degree of severity of the head injury and the amount of generalised abnormality in the EEG.²¹ He was able to conclude that EEGs were an index of active cerebral abnormality after a head injury and when correlated with the patient's history and other signs could help estimate the extent of cerebral damage. He warned that while the rate of clinical and EEG recovery in this series of acute head injuries corresponded closely, there were wide individual variations in the speed of recovery. He further concluded that EEGs could not be used to predict traumatic epilepsy during the period of recovery from a head injury. In a further study published in 1944, he analysed the disturbances in the EEG and found that these occurred in 25% of patients with post-traumatic epilepsy compared with 56% of those with 'idiopathic' epilepsy.²²

Fundamental research

In London, consultants at the voluntary hospitals would not collaborate with the universities. In Oxford, Lord Nuffield had initiated the school of medicine to break away from this isolationist tradition. When Cairns was appointed Nuffield Professor of Surgery, this gave him authority and as director of St Hugh's he had a clinical base to implement a German professorial style department from which he could instigate fundamental research in different areas. He encouraged his postgraduate students to document cases, follow up patients and contribute to clinical and fundamental research. In addition, through close collaboration with their research colleagues in the nearby hospitals and adjacent university research departments, the staff at St Hugh's were able to participate and contribute to both fundamental and clinical research.

Three key factors came into play: they were highly trained researchers prior to coming to St Hugh's, they were working full-time, and the large number of patients provided them with rich material and invaluable clinical experience. They could avail themselves of the different university departments to work with outstanding researchers who in turn were delighted to have access to patients so that a very fruitful collaboration ensued. Cairns himself cooperated with Hylas Holborn from the Physics Laboratory to study the effect of deceleration in motorcycle accidents and this research led to the compulsory wearing of helmets for motorcyclists in the armed forces.⁵ He worked with John Z Young from the Departments of Anatomy, Zoology and Physiology on the treatment of gunshot wounds of peripheral nerves.²³ With his St Hugh's colleagues, Lewin, Duthie and Smith, Cairns worked in collaboration with Florey who was developing penicillin at the William Dunn School of Pathology and carried out clinical trials on infected patients.¹⁵ Further studies on the use of penicillin for the treatment of tuberculous meningitis were instigated by Smith at the Neurosurgery Department at the Radcliffe Infirmary. Williams, from the Anatomical and Physiological Departments, worked in collaboration with Denny-Brown to study the use of EEGs for diagnosis and monitoring purposes and to carry out concussion studies in cats, intracranial pressure and brain swelling.²⁴ Ludwig Guttmann, who was working at Seddon's

Peripheral Nerve Injury unit at the Wingfield Morris Hospital, collaborated with George Weddel on nerve regeneration studies and also carried out research on sweating using the dye quinizarin at St Hugh's.²⁵

Conclusion

Aminoff aptly described the 'cross fertilization' of ideas which was taking place in Oxford:

Major advances in surgical neurology, pathology, experimental physiology and other fields of medicine stemmed from fertile interactions with one another. The earlier pioneers of neurological surgery appreciated that medical specialisation was unlikely to advance very far in a vacuum. They learned from neurology and borrowed from other disciplines. Successes in the operating room stimulated additional anatomical and physiological explorations with laboratory animals. Such studies and the cross fertilization of disciplines shed additional light on such things as the functional organisation of the brain.²⁶

This cross fertilisation of ideas resulted in life-saving treatments and discoveries. Just as Robert Jones contributed to the establishment of orthopaedics as a speciality after treating a large number of catastrophic injuries during the First World War, so Cairns and his colleagues at St Hugh's established the blueprint for the treatment of head injuries and laid the foundation for the development of neurology and neurosurgery as established and recognised specialities in the UK.

A whole generation of neurologists and neurosurgeons worked at St Hugh's during the Second World War. It became their 'alma mater' and they regarded the place with the same affection and gratitude that might be given to a college or other similar institution.²⁷ St Hugh's proved to be a valuable training centre, not only for the Army's neurologists and neurosurgeons but for other members of neurosurgical units across the country. Virtually all the neurologists and neurosurgeons involved in setting up the post war neurosurgical services across the UK were trained at St Hugh's. Two people were thought to be so important and influential that they were requested by the respective governments to set up units. Denny-Brown became professor of neurology at Harvard and Murray Falconer went to New Zealand to receive neurosurgical casualties. Research into the autonomic system initiated by Guttmann and David Whitteridge through collaboration between the physiology department and the Wingfield Morris Hospital continued with JMK Spalding in the neurology department and the physiology department.

Seddon's peripheral nerve injury unit at the Wingfield Morris Hospital in Oxford nurtured several important figures. Guttmann set up the National Spinal Injury Centre, established the speciality of spinal injuries and the Paralympics sports movement. Ruth Bowden became professor of anatomy at the Royal Free Hospital, Donal Brooks became director of

the peripheral nerve injury service at the Royal National Orthopaedic Hospital, Young became professor of anatomy at Oxford and Medawar had a distinguished career culminating in winning the Nobel Prize.

What Cairns and his team of gifted neurologists and neurosurgeons achieved in such a short period of time is extraordinary. They laid the foundations upon which others could build to develop the neurological and neurosurgical services in England and beyond. ①

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