The Acute STroke Registry and Analysis of Lausanne (ASTRAL)
Design and Baseline Analysis of an Ischemic Stroke Registry Including Acute Multimodal Imaging

Patrik Michel, MD; Céline Odier, MD; Matthieu Rutgers, MD; Marc Reichhart, MD; Philippe Maeder, MD; Reto Meuli, MD; Max Wintermark, MD; Ali Maghraoui; Mohamed Faouzi, PhD; Alexandre Croquelois, MD; George Ntaios, MD

Background and Purpose—Stroke registries are valuable tools for obtaining information about stroke epidemiology and management. The Acute STroke Registry and Analysis of Lausanne (ASTRAL) prospectively collects epidemiological, clinical, laboratory and multimodal brain imaging data of acute ischemic stroke patients in the Centre Hospitalier Universitaire Vaudois (CHUV). Here, we provide design and methods used to create ASTRAL and present baseline data of our patients (2003 to 2008).

Methods—All consecutive patients admitted to CHUV between January 1, 2003 and December 31, 2008 with acute ischemic stroke within 24 hours of symptom onset were included in ASTRAL. Patients arriving beyond 24 hours, with transient ischemic attack, intracerebral hemorrhage, subarachnoidal hemorrhage, or cerebral sinus venous thrombosis, were excluded. Recurrent ischemic strokes were registered as new events.

Results—Between 2003 and 2008, 1633 patients and 1742 events were registered in ASTRAL. There was a preponderance of males, even in the elderly. Cardioembolic stroke was the most frequent type of stroke. Most strokes were of minor severity (National Institute of Health Stroke Scale [NIHSS] score ≤4 in 40.8% of patients). Cardioembolic stroke and dissections presented with the most severe clinical picture. There was a significant number of patients with unknown onset stroke, including wake-up stroke (n=568, 33.1%). Median time from last-well time to hospital arrival was 142 minutes for known onset and 759 minutes for unknown-onset stroke. The rate of intravenous or intraarterial thrombolysis between 2003 and 2008 increased from 10.8% to 20.8% in patients admitted within 24 hours of last-well time. Acute brain imaging was performed in 1695 patients (97.3%) within 24 hours. In 1358 patients (78%) who underwent acute computed tomography angiography, 717 patients (52.8%) had significant abnormalities. Of the 1068 supratentorial stroke patients who underwent acute perfusion computed tomography (61.3%), focal hypoperfusion was demonstrated in 786 patients (73.6%).

Conclusions—This hospital-based prospective registry of consecutive acute ischemic strokes incorporates demographic, clinical, metabolic, acute perfusion, and arterial imaging. It is characterized by a high proportion of minor and unknown-onset strokes, short onset-to-admission time for known-onset patients, rapidly increasing thrombolysis rates, and significant vascular and perfusion imaging abnormalities in the majority of patients. (Stroke. 2010;41:2491-2498.)

Key Words: acute ischemic stroke ■ stroke registry ■ CT angiography ■ perfusion CT

Stroke registries constitute a valuable tool for obtaining information on epidemiology, clinical course, and diagnostic evaluation of stroke patients and can help assess the efficacy of their treatment and their functional outcome in a hospital or population setting. They may serve as audits to evaluate the quality of stroke management and identify possibilities for improvement. Moreover, they enable the design of adequately powered clinical trials, monitor secular trends in epidemiological indices, and compare different populations to identify potential differences.1

The Acute STroke Registry and Analysis of Lausanne (ASTRAL) is a prospective project designed to assemble state-of-the-art data for all ischemic stroke patients hospitalized in the stroke unit of the neurology service, and/or the

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From the Neurology Service (P.M., C.O., M.Ru., M.Re., G.N.), Service of Diagnostic and Interventional Radiology (P.M., R.M.), Division of Clinical Pharmacology (A.M.), Institute of Social and Preventive Medicine (M.F.), and Service of Neuropsychology and Rehabilitation (A.C.), Centre Hospitalier Universitaire Vaudois and University of Lausanne, Lausanne, Switzerland; Department of Radiology, Division of Neuroradiology (M.W.), University of Virginia, Charlottesville, Va.

The online-only Data Supplement is available at http://stroke.ahajournals.org/cgi/content/full/STROKEAHA.110.596189/DC1.
Correspondence to Patrik Michel, MD, Neurology Service, Centre Hospitalier Universitaire Vaudois and University of Lausanne, Rue du Bugnon 46, CH-1011 Lausanne, Switzerland; E-mail patrik.michel@chuv.ch
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2491
intensive care unit of the Centre Hospitalier Universitaire Vaudois (CHUV). This stroke unit is the only one in the wider area of Lausanne, Switzerland with a population of approximately 270 000. Moreover, this stroke unit also serves as a reference center for 15 referral hospitals in the canton of Vaud and for parts of 3 neighboring cantons, bringing the total population served to approximately 1.2 million.

In the present paper, we aim to provide a comprehensive description of the design and methods used to create ASTRAL. Furthermore, we present a descriptive analysis of the epidemiological, etiologic, clinical, metabolic, imaging, therapeutic, diagnostic, and outcome data of our patients.

Methods
ASTRAL was designed to be a data bank of acute ischemic stroke patients that incorporates detailed clinical and laboratory data and modern brain imaging techniques to analyze underlying causes and mechanisms of ischemic stroke; integrate clinical and radiological data from multimodal acute stroke imaging; follow trends of the characteristics of ischemic stroke in the specific region; compare the study population with similar data sets in other geographic, ethnic, or racial populations; and, design adequately powered prevention and interventional clinical trials. This database is completely independent from the Lausanne Stroke Registry (LSR),2,3 which was terminated by its initiator at the end of 2004.

Inclusion Criteria
All consecutive patients who were admitted to the stroke unit and/or intensive care unit of the CHUV with a main discharge diagnosis of acute ischemic stroke were included in ASTRAL, beginning on January 1, 2003. The patients who required intensive care unit admission at any point during hospitalization (<5% of all patients) were under the medical responsibility of intensive care specialists during that phase but were followed regularly by the stroke team. Stroke is defined as a new syndrome of rapidly developing clinical symptoms and/or signs of focal disturbance of cerebral function lasting longer than 24 hours with no apparent cause other than vascular origin, regardless of whether infarction was evident on cerebral radioimaging.4 Only patients admitted within 24 hours of ischemic stroke onset (or last-well time) were included. Patients with in-hospital stroke were only included if stroke was the main pathology warranting treatment in the stroke unit and/or in the intensive care unit. Recurrent acute ischemic strokes were registered in ASTRAL as new events unless the recurrent event happened during hospitalization for the previous stroke.

Exclusion Criteria
Patients with transient ischemic attack (TIA, defined as complete disappearance of signs and symptoms within 24 hours, regardless of age distribution of ASTRAL patients according to sex (white bars for females, gray bars for males). Asterisks indicate significant difference in the frequency of stroke between males and females by \( \chi^2 \) test (level of significance at \( P=0.05 \)). Comparison of frequency of stroke between males and females in each age group was performed by \( \chi^2 \) test.

Table 1. Demographic and Geographic Data in ASTRAL

<table>
<thead>
<tr>
<th>Demographic Parameter</th>
<th>Sex, n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>764 (43.9)</td>
</tr>
<tr>
<td>Male</td>
<td>978 (56.1)</td>
</tr>
<tr>
<td>Age (median in years±SD)</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>72 ±15.75</td>
</tr>
<tr>
<td>Male</td>
<td>73 ±15.83</td>
</tr>
<tr>
<td>First strokes</td>
<td>71±16.34</td>
</tr>
<tr>
<td>Recurrent strokes</td>
<td>75±13.97</td>
</tr>
<tr>
<td>Ethnicity, n (%)</td>
<td></td>
</tr>
<tr>
<td>Caucasian</td>
<td>1677 (96.3)</td>
</tr>
<tr>
<td>African, Black</td>
<td>23 (1.3)</td>
</tr>
<tr>
<td>African, Maghreb</td>
<td>15 (0.9)</td>
</tr>
<tr>
<td>East Asian</td>
<td>3 (0.2)</td>
</tr>
<tr>
<td>Middle East</td>
<td>13 (0.7)</td>
</tr>
<tr>
<td>South Asian</td>
<td>6 (0.3)</td>
</tr>
<tr>
<td>American-Latin</td>
<td>7 (0.4)</td>
</tr>
<tr>
<td>Insurance, n (%)</td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>1407 (80.8)</td>
</tr>
<tr>
<td>Private/semiprivate</td>
<td>335 (19.2)</td>
</tr>
<tr>
<td>Transport from, n (%)</td>
<td></td>
</tr>
<tr>
<td>Lausanne area</td>
<td>1275 (74.9)</td>
</tr>
<tr>
<td>Acute referrals from other centers</td>
<td>427 (25.1)</td>
</tr>
<tr>
<td>Orientation at discharge, n (%)</td>
<td></td>
</tr>
<tr>
<td>Home</td>
<td>649 (39.3)</td>
</tr>
<tr>
<td>Rehabilitation center</td>
<td>598 (36.2)</td>
</tr>
<tr>
<td>Long term care institution including palliative care institution</td>
<td>59 (3.6)</td>
</tr>
<tr>
<td>In-hospital death</td>
<td>133 (8.1)</td>
</tr>
<tr>
<td>Other acute care hospital or speciality</td>
<td>213 (12.9)</td>
</tr>
<tr>
<td>Median length of hospitalization (days±SD)</td>
<td>10±8.01</td>
</tr>
</tbody>
</table>

n indicates events.
infarction being shown on neuroimaging, intracerebral hemorrhage, subarachnoidal hemorrhage, cerebral sinus venous thrombosis, and late admission >24 hours after stroke onset) are excluded. All excluded patients were registered in a parallel database (ASTRAL-E).

Collection, Storage, Handling, and Analysis of Data
ASTRAL was designed, initiated, and has been maintained by the first author (P.M.) since April 1, 2002. Herein, we report baseline data of patients admitted to the neurology department between January 1, 2003 and December 31, 2008. ASTRAL was approved by the Medical School Ethics Committee of the University of Lausanne. Initially, data were collected in a Microsoft Excel spreadsheet. Recently, the registry was converted to a Microsoft Access database.

Stroke Onset, Arrival Pathways, Time Intervals, and Vascular Risk Factors
The exact time of onset of symptoms (or the last time that patient was reported to be well), the arrival pathways, the mode of transport to CHUV, the exact time of arrival, as well as the time intervals from stroke onset to brain imaging and to acute intervention (if performed) were all recorded. Strokes were considered to be of unknown onset if more than 60 minutes elapsed between last time of well being and time of stroke discovery. The definitions of vascular risk factors are presented in Appendix A (available at http://stroke.ahajournals.org).

Stroke Characteristics
The National Institute of Health Stroke Scale (NIHSS) score is recorded systematically on admission 6 and 24 hours after hospital arrival. Stroke subtype is classified according to the Trial of ORG 10172 in Acute Stroke Treatment (TOAST) classification, modified for cardiac sources according to the SSS-TOAST algorithm. The categories “likely ath erosclerotic stroke,” “multiple coexisting causes,” “dissections,” and “likely patent foramen ovale” in patients with no other causes nor significant vascular risk factors are separately listed.

Brain Parenchymal and Perfusion Imaging
All ischemic stroke patients undergo acute brain parenchymal imaging (computed tomography [CT] or magnetic resonance imaging [MRI]) as soon as possible after arrival in the emergency room. Early ischemic changes, old strokes, leukoaraiosis (Blenow Type 1 or more), and hemorrhagic infarction are noted. The choice of imaging modality and our contrast policy, following international recommendations, are described in Appendix B (available at http://stroke.ahajournals.org). Currently, multimodal CT imaging is the most frequently used method in the acute phase in our institution. Perfusion CT is performed in most patients with acute hemispheric or nonlocalizable stroke symptoms according methods described elsewhere. Arterial and perfusion imaging is not used as selection criteria for patients fulfilling the European Stroke Organisation recommendations for intravenous thrombolysis, but may be used for endovascular treatment decisions, according to Swiss national recommendations.

Arterial Imaging Data During Acute Phase
All ischemic stroke patients underwent acute arterial imaging (CT angiography, MR angiography, carotid and transcranial Doppler, or conventional angiography) within 24 hours of admission if there were no contraindications. The method of choice were CT angiography due to availability and complete visualization of the cervical and cerebral arteries. Acute conventional angiography was added when intravascular treatment is likely. Arterial abnormalities were considered significant if occlusion, ≥50% stenosis, or any signs of dissection are present.

Follow-Up Brain Imaging and Arterial Data
Most patients were followed up with a second CT or MRI during the first weeks after stroke. Follow-up subacute arterial imaging (CT angiography, MR angiography, or Doppler) was performed in most patients who had an arterial pathology in the acute phase to investigate whether recanalization had occurred.

Clinical Follow-Up
The patient’s handicap was systematically recorded at 7 days, 3 months, and 12 months after stroke, either in person at the outpatient
stroke clinic or by phone by medical personnel. In case of a suspected recurrent cerebrovascular event, confirmation was sought from the treating general physician or hospital. If a patient could not be reached, local citizen registries were checked. Finally, when a patient passed away during the follow-up period, the cause of death was recorded according to medical records and the death certificate. For the current publication, data are given for patients from 2003 to 2007 given that follow-up information is only fully available 1 year after the stroke.

Statistical Analysis
Gaussian-distributed continuous parameters were reported as mean±standard deviation (SD), whereas continuous variables with non-Gaussian distribution are reported as median±SD. Comparison of frequencies of categorical variables was performed by χ² test. The Student two-tailed unpaired t-test was used to compare means. The level of significance was set at 95% (P=0.05).

Results
Between January 1, 2003 and December 31, 2008, 1742 events were registered in ASTRAL in 1633 patients, and 1423 events were excluded and instead registered in the parallel registry (ASTRAL-E). Reasons for exclusion included late arrival (623 patients), TIA (577 patients), retinal ischemia (57 patients), and intracranial hemorrhage (166 patients). Considering that 74.9% of patients came from the primary catchment area (Lausanne and surrounding area) of a well-defined population of 270,000, and that the number of events entered annually in ASTRAL has remained stable during the 6 years reported (2003–2008), we estimate an annual rate of acute ischemic stroke hospitalizations in our stroke unit or intensive care unit of 80.5 per 100,000 inhabitants. The main demographic data of ASTRAL patients are summarized in Table 1. There was a male preponderance in the overall population and in all age groups, except the 50- to 54-year group (Figure 1).

Table 2 shows the incidence of the main risk factors, as well as comorbid conditions and previous medications. As expected, we noticed a significant difference in the last-well time to admission interval between strokes with known (1146 events, 66.9%) and unknown onset (568 events, 33.1%), the median values (±standard deviation) being, respectively, 142 (±304.7) minutes and 759 (±331.3) minutes (P<0.0001). Of
respectively (Figure 2). All events, 161 (9.4%), 480 (28%), and 708 (41.3%) patients were admitted within 1, 2 and 3 hours after last-well time, respectively (Figure 2).

Most strokes were of minor severity (NIHSS ≤ 4 in 40.8% of patients, Figure 3). Cardioembolic stroke consisted the most frequent type of stroke (Table 3). Dissections and cardioembolic stroke presented with the most severe clinical pictures, whereas lacunar strokes were the mildest. In overall, modified Rankin score was 0 in 235 patients (18.4%), 1 in 104 (8.2%), 2 in 228 (16.6%), 3 in 152 (11.1%), 4 in 123 (9.0%), 5 in 51 (3.7%), and 6 (death) in 209 (15.2%).

In 1072 events (62.1%), the affected territory involved the anterior, in 496 events (29%) the posterior circulation. Both acute stroke of other determined origin (9.4%) had acute bilateral lesions, and in 12 events (0.7%), the side could not be determined with confidence. The main reasons for nonavailability of a perfusion CT image in supratentorial stroke were as follows: not requested by the physician in 138 events (24.1%), renal insufficiency in 132 (23%), known contrast allergy in 21 (3.7%), agitated or moving patient in 12 (2.9%), and technical failure in 7 (1.2%). In 1068 patients with good quality perfusion CT, focal hypoperfusion was found in 786 of scans (73.6%).

There was a gradual increase between 2003 and 2008 in the proportion of patients treated with intravenous or intraarterial thrombolysis (Figure 4). In 2008, 63 of all strokes in the registry (20.9%) received intravenous thrombolysis according to European Stroke Organisation guidelines (<180 minutes until October 2008, or <270 minutes thereafter), and a minority (0.7%) received intraarterial recanalization treatments within 6 hours. Since 2003, the goal of patients being treated within 60 minutes of hospital arrival was accomplished in 171 of 267 intravenous thrombolyses (64%).

### Table 3. Frequency of Stroke Subtypes Using the ASTRAL Classification, According to Sex, NIHSS at Admission and Median Age

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Total N (%)</th>
<th>Female n (%)</th>
<th>Male n (%)</th>
<th>NIHSS Mean ± SD</th>
<th>Age (Years) Median ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large-artery atherosclerosis</td>
<td>250 (14.4)</td>
<td>123 (49.2)</td>
<td>127 (50.8)</td>
<td>6.8±6.1</td>
<td>71.5±14.6</td>
</tr>
<tr>
<td>Likely cardioembolic stroke</td>
<td>218 (12.5)</td>
<td>60 (38.0)</td>
<td>158 (62.0)</td>
<td>9.9±7.7</td>
<td>73.0±11.9</td>
</tr>
<tr>
<td>Cardioembolic stroke</td>
<td>497 (28.5)</td>
<td>238 (47.9)</td>
<td>259 (52.1)</td>
<td>11.3±8.3</td>
<td>77.0±13.5</td>
</tr>
<tr>
<td>Lacunar stroke</td>
<td>257 (14.8)</td>
<td>112 (43.6)</td>
<td>145 (56.4)</td>
<td>4.2±2.7</td>
<td>72.0±12.0</td>
</tr>
<tr>
<td>Dissection</td>
<td>92 (5.3)</td>
<td>34 (41.5)</td>
<td>48 (58.5)</td>
<td>11.3±8.8</td>
<td>48.0±11.0</td>
</tr>
<tr>
<td>Acute stroke of other determined origin</td>
<td>68 (3.9)</td>
<td>28 (41.2)</td>
<td>40 (58.8)</td>
<td>9.1±7.5</td>
<td>63.0±14.3</td>
</tr>
<tr>
<td>Undetermined causes</td>
<td>208 (11.9)</td>
<td>104 (50.0)</td>
<td>104 (50.0)</td>
<td>9.7±9.2</td>
<td>72.0±17.8</td>
</tr>
<tr>
<td>Coexisting and multiple causes</td>
<td>85 (4.9)</td>
<td>32 (37.6)</td>
<td>53 (62.4)</td>
<td>9.9±7.7</td>
<td>77.0±12.5</td>
</tr>
<tr>
<td>Likely patent foramen ovale</td>
<td>67 (3.8)</td>
<td>30 (44.8)</td>
<td>37 (55.2)</td>
<td>6.6±6.7</td>
<td>45.0±13.9</td>
</tr>
</tbody>
</table>

n indicates events.

### Table 4. Physiological and Metabolic Parameters in ASTRAL

<table>
<thead>
<tr>
<th>Physiological/Metabolic Parameter</th>
<th>&lt;24 hours (± SD)</th>
<th>At 24–48 hours (± SD)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature (°C)</td>
<td>36.42±0.66</td>
<td>36.77±0.67</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Heart rate (min⁻¹)</td>
<td>79.49±18.06</td>
<td>77.42±21.5</td>
<td>0.0003</td>
</tr>
<tr>
<td>Glucose (mmol/L)</td>
<td>7.17±4.03</td>
<td>6.03±1.75</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Systolic blood pressure (mm Hg)</td>
<td>159.6±28.87</td>
<td>140.66±23.29</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Diastolic blood pressure (mm Hg)</td>
<td>90.29±17.49</td>
<td>68.39±15.38</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Serum creatinine (mmol/L)</td>
<td>89.32±38.15</td>
<td>105.1±60.92</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total cholesterol (mmol/L)</td>
<td>5.62±4.77</td>
<td>8.64±4.59</td>
<td></td>
</tr>
<tr>
<td>White blood cell count (×10³/L)</td>
<td>232.39±73.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Platelet count (×10³/L)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hemoglobin (g/L)</td>
<td>131.4±15.81</td>
<td>143.08±16.39</td>
<td></td>
</tr>
</tbody>
</table>

All values are mean±SD. Paired t test was performed to compare acute with subacute values.
This article presents the methodology and descriptive analysis of all consecutive patients with acute ischemic stroke admitted to a single stroke unit between 2003 and 2008. Compared with existing hospital-based stroke registries, this is the first registry to incorporate data from multimodal imaging including brain parenchymal, vascular, and perfusion imaging. This data will help scientists understand stroke pathogenesis and potential effectiveness of treatments aimed at recanalization and salvage of the penumbra. Given this focus on arterial and perfusion imaging, ASTRAL included only ischemic stroke patients. As opposed to the previous Lausanne Stroke Registry, we also included patients with recurrent stroke; in fact, 15.9% of our patients had had previous clinical strokes. Adding these patients gives a more realistic view of acute ischemic stroke patients, given the high recurrence rate of ischemic vascular diseases and particularly ischemic stroke. Similarly, the 1-year follow-up of patients after their index stroke will allow for better understanding of risk factors for recurrences and of poor outcome.

We were surprised to find a persistence of higher stroke admissions rates for male patients even in oldest age strata, contrary to incidence studies showing an inverse trend. We also found a higher median age of ASTRAL patients as compared with the Lausanne Stroke Registry. This was likely related to the inclusion of patients with previous strokes who were older rather than to the exclusion of intracerebral hemorrhages, given that the latter population had a similar median age (data not shown).

We found the median onset-to-admission time interval for patients with known-onset stroke to be 143 minutes. Sixty-nine percent of these patients arrived within 4 hours, potentially allowing them to receive intravenous thrombolysis according to current recommendations. Thanks to these short intervals to admission, the rate of intravenous-thrombolysis within evidence-based time limits progressively increased to a current 20.6% of all ASTRAL patients. In contrast, an impressive 40.8% of patients had minor strokes with NIHSS ≤4 who are often not considered for thrombolysis. Therefore, the main reason for nonthrombolysis in ASTRAL was low NIHSS rather than late arrival time.

### Table 5. Acute Brain (Parenchymal and Vascular) Imaging Modalities and the Main Results

<table>
<thead>
<tr>
<th></th>
<th>Computed Tomography</th>
<th>Magnetic Resonance Imaging</th>
<th>Computed Tomography Angiography</th>
<th>Magnetic Resonance Angiography</th>
<th>Doppler</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. performed</td>
<td>1618 (92.9%)</td>
<td>52 (3.0%)</td>
<td>1358 (78%)</td>
<td>57 (3.3%)</td>
<td>238 (13.7%)</td>
</tr>
<tr>
<td>Early ischemic changes</td>
<td>537 (33.2%)</td>
<td>47 (90.4%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spontaneous hemorrhagic</td>
<td>9 (0.6%)</td>
<td>1 (1.9%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>hemorrhagic transformation</td>
<td>355 (21.9%)</td>
<td>2 (3.8%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Old strokes</td>
<td>440 (27.2%)</td>
<td>2 (3.8%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No significant vascular</td>
<td>641 (47.2%)</td>
<td>36 (63.2%)</td>
<td>143 (60.1%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pathology</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pathology in ischemic territory only</td>
<td>569 (41.9%)</td>
<td>17 (30.0%)</td>
<td>68 (28.6%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pathology in ischemic and</td>
<td>107 (7.9%)</td>
<td>4 (7.0%)</td>
<td>14 (5.9%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>nonischemic territory</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pathology in non-ischemic</td>
<td>41 (3.0%)</td>
<td>0 (0.0%)</td>
<td>13 (5.5%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>territory only</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

### Figure 4. Annual numbers of acute recanalization treatments given to stroke events in ASTRAL. EVT indicates endovascular treatment.
For the 34.1% patients with unknown-stroke onset as defined by more than 1 hour of uncertainty since last-well time, standard time windows make thrombolysis virtually impossible. Such patients may benefit in the future from radiological selection criteria for acute recanalization treatments.29

Whereas blood pressure, heart rate, and glucose values decreased significantly during the first 24 hours, increasing mean temperature is possibly due to stroke-related infections and opens the door for more aggressive preventive measures.

Systematic CT-based multimodal imaging in ASTRAL patients lead to a high rate of acute noninvasive arterial imaging (78% of all patients) and perfusion imaging in patients with supratentorial strokes (73.9%). With perfusion CT in supratentorial stroke, the sensitivity of acute stroke more than doubled to 73.9% when compared with noncontrast CT alone. Acute arterial imaging showed cervical or intracranial pathology relevant to the current stroke in only 41.9% of patients, in keeping with an important number of mild strokes in our population. The probable risk of inducing cancer by radiation, particularly in younger subjects and with multiple exposures,30 should be balanced against the potential benefit in each patient.

Our study has several limitations: as a hospital-based registry, the data may not reflect the entire stroke population of the region. Indeed, patients entered in ASTRAL account for an annual rate of acute ischemic stroke hospitalized in our stroke unit or intensive care unit of 80.5 per 100,000 inhabitants, which is lower than the estimated stroke incidence of 296.3 per 100,000 for this population in 2004.31 This may be due to exclusion from the registry of subacute strokes (>24 hours), intracerebral hemorrhage, and subarachnoid hemorrhage, and because patients with minor or immediately lethal stroke are potentially not diagnosed or hospitalized. Furthermore, some patients with minor strokes may be admitted to private hospitals in Lausanne. However, because the ambulance services of our region are instructed to transfer suspected stroke patients to the CHUV (which hosts the only stroke unit and neurology service in the region), it is likely that the 74.9% of patients in ASTRAL coming from the primary catchment are representative of the local population. Second, using the traditional definition of TIA,5 we have probably excluded some patients from our register who would be considered to have had strokes according to the recently proposed definition.32 Using our TIA patients (from ASTRAL-E), we could potentially compare patients with the traditional and the recently proposed new definitions for TIA. In summary, we present the methodology and baseline results of ASTRAL, which is a hospital-based acute ischemic stroke registry. As particular features, ASTRAL incorporates data on acute metabolic parameters, multimodal brain imaging, and recurrence rates. Our analysis yields interesting epidemiological and pathophysiological data, allows for modern clinico-radiological correlations, and acts as an audit for pre-hospital and in-hospital management of stroke.

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Disclosures

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Patrik Michel, Céline Odier, Matthieu Rutgers, Marc Reichhart, Philippe Maeder, Reto Meuli, Max Wintermark, Ali Maghraoui, Mohamed Faouzi, Alexandre Croquelois and George Ntaios

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Appendix A: Definitions of risk factors

**Arterial hypertension**: systolic blood pressure >140 mmHg or diastolic blood pressure >90 mmHg measured at discharge.

**Diabetes mellitus**: fasting plasma glucose >126 mg/dl (7.0 mmol/l), a 2-hour value in the oral glucose tolerance test >200 mg/dl (11.1 mmol/l), a random plasma glucose concentration >200 mg/dl (11.1 mmol/l) in the presence of symptoms.

**Glucose intolerance**: 2-hour plasma glucose value between 140-199 mg/dl (7.8-11.0 mmol/l) during a 75gr oral glucose tolerance test.

**Dyslipidemia**: LDL >100mg/dl (2.6mmol/l). If not available, total cholesterol >200mg/dl (5mmol/l).

**Smoking status**: smokers are distinguished in never-smokers, active smokers (current smoker and smokers who quit within last two years) and past smokers (quit smoking more than two years ago).

**Atrial fibrillation** (paroxysmal, persistent, or permanent): is considered to be present if there is more than one documented episode of atrial fibrillation.

**Documented coronary heart disease**: Is considered to be present if myocardial infarction has been documented (enzymes, ECG, and/or coronary angiography) or if symptoms of angina pectoris have been explained by pathological coronary angiography.

**Low ejection fraction**: is considered to be present if the ejection fraction is < 35%

**Symptomatic peripheral artery disease**: Is considered to be present if typical symptoms are explained by non-invasive or invasive testing.

**Obesity**: Body mass index (BMI) was calculated from measured or historical height and weight. Definitions of obesity are used according to the World Health Organisation.

Appendix B: Recommendations for acute imaging of ischemic stroke and transient ischemic attack
in the emergency room at the CHUV, with precautions based on the literature 10,11,12

Recommended imaging modality
Any patient suffering from hemispheric or non-localisable stroke symptoms reaching the emergency room within 24 hours of first symptoms should undergo: emergent consultation by a neurologist and
1. plain and contrast enhanced cerebral computed tomography (CT)
2. cerebro-cervical CT angiography
3. perfusion CT of the hemispheres (exception: agitated patient)

Patients reaching the emergency room beyond 24h after first symptoms, patients with suspected posterior fossa stroke and with TIA should undergo: emergent consultation by a neurologist and
1. plain and contrast enhanced cerebral computed tomography (CT)
2. cerebrocervical CT angiography

MRI is the preferred first imaging modality in the following situations:
1. pregnancy
2. contraindication for iodinated contrast (see below)
3. uncertainty about the clinical diagnosis of stroke or TIA
4. unusual stroke syndromes or etiology
5. posterior fossa lesions that cannot be localised clinically

Cautions about contrast use
Examples with known allergy to iodinated contrast should not be injected acutely. If creatinine blood level is unknown and no history of renal failure is reported, the use of contrast dye is permitted in an emergency situation without waiting for the result of the creatinine serum level. If creatinine blood level is available and above normal values, creatinine clearance must be calculated with the Cockroft formula.
1. Creatinine clearance <30 ml/min.: contrast dye (iodinated contrast or gadolinium) must not be used
2. Creatinine clearance between 30-50 ml/min.
   a. if iodinated contrast is used, start normal saline 300ml in 30 min, then 1ml/kg/hour for 12 hours (except in presence of cardiac failure) and give N-acetylcysteine 600 mg per os (or via nasogastric tube or intravenous) twice a day for 48h.
   b. gadolinium is allowed with caution
3. If the patient is currently treated with metformin
   a. if clearance <50ml/min: no iodinated contrast dye must be used
   b. if clearance >50ml/min: iodinated contrast dye is permitted, but metformin must be discontinued. If creatinine blood level does not increase within 48h, the treatment can be resumed.
   c. gadolinium: according to point 1 and 2
4. Renal dialysis patients
   a. if urinary production <500ml/day: iodinated contrast dye is permitted
   b. if urinary production >500ml/day or unknown: no contrast dye must be used (unless absolutely necessary)
c. gadolinium is contraindicated
5. Known multiple myeloma:
   a. no iodinated contrast
   b. gadolinium: according to points 1 to 4

Radiation exposure information:
The current radiation exposure for a complete CT, perfusion CT with 16 slices, and CTA including cervical and cerebral arteries at the CHUV is currently 13.7 mSV (plain CT: 2X3 mSV, CTP: 3 mSV, CTA: 4.7mSV).