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# Ischemic Stroke Subtypes in Pakistan: The Aga Khan University Stroke Data Bank

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## Abstract

**Objective:** Frequency of ischemic stroke subtypes is influenced by ethnic and geographic variables. Our objective was to identify various stroke subtypes and its determinants at a tertiary care hospital.

**Methods:** We prospectively collected data on ischemic stroke subtypes admitted to The Aga Khan University Hospital in Karachi.

**Results:** A total of 596 patients were enrolled in 22 months in the Aga Khan University Stroke Registry. These included 393 patients with Ischemic stroke, 126 patients with intracerebral hemorrhage, 50 patients with subarachnoid hemorrhage and others. The ischemic stroke group was classified according to the TOAST criteria and comprised of lacunar 168/393 (42.7%); large artery atherosclerosis 106/393 (26.9%); cardioembolic 24/393 (6.1%); undetermined 80/393 (20.3%); and other determined types 15/393 (3.8%). The high proportion of lacunar strokes in our population may be due to high burden of inadequately treated hypertension and diabetes. Clear cut cardioembolic stroke was relatively infrequent in our population.

**Conclusion:** Lacunar stroke is the most common subtype of stroke in our patient population. This is most likely secondary to uncontrolled hypertension (JPMA 53:584;2003).

## Introduction

The various stroke subtypes have demonstrated significant variability between different geographical regions as well as different ethnic groups within the same geographic region.<sup>1-10</sup> These differences in stroke characteristics have significant impact on strategies of stroke prevention, diagnosis and treatment.

Stroke data banks are helpful in elucidating the risk factors and stroke subtypes in target populations. Although population based studies are superior in answering questions such as incidence and prevalence, hospital based stroke data banks have the advantage of more uniformly evaluating patients with ancillary investigations such as magnetic resonance imaging (MRI), carotid doppler ultrasonography etc. This may result in a more reliable determination of stroke subtype and underlying risk factors.

This paper presents the results of the hospital based Aga Khan University Stroke Data Bank evaluating stroke patients admitted to a large tertiary care medical center between August 1999 and May 2001.

In the present study we analyzed the data to study the distribution of different stroke types, and to determine the relative frequency of some well established vascular risk factors in our stroke population. To our knowledge, such a prospective study has not been undertaken in Pakistan.

## Methods

The Aga Khan University Hospital is a major tertiary care health facility with a busy Neurology service. Acute stroke patients presenting to the hospital were admitted to the Neurology Service. All acute stroke patients over the age of 14 yrs are eligible to be enrolled in the Aga Khan University

Stroke Data Bank. Patients with subarachnoid, subdural or epidural hemorrhage are excluded from the Data bank. The data Bank has been prospectively enrolling acute stroke patients since August 1999.

Acute stroke was defined as rapidly evolving focal or global loss of cerebral function with symptoms leading to death or lasting more than 24 hours due to a vascular etiology.<sup>11</sup>

The definition of the strokes subtypes was adapted from the TOAST trial<sup>12</sup> (Trial of Org 10172 in Acute Stroke Treatment):

- 1) Large artery atherosclerosis; clinical and radiological findings of either occlusion or stenosis ( $>50\%$ ) of major brain artery or branch cortical artery and absence of features suggestive of other stroke subtypes,
- 2) Small artery occlusion (lacunar strokes); clinical lacunar syndrome, with no evidence of cortical dysfunction, and either a normal brain CT/MRI or a relevant subcortical hemispheric / brain stem infarction of less than 1.5 cm. No evidence of other stroke subtype.
- 3) Cardioembolism; at least one major cardiac risk factor for embolism and absence of features to suggest other stroke subtype,
- 4) Stroke of other determined etiology; absence of features suggestive of aforementioned stroke subtypes and evidence of other risk factors of stroke e.g. a hypercoagulable state, nonatherosclerotic vasculopathy etc, and
- 5) Stroke of undetermined etiology; presence of two or more potential causes of stroke or no etiology found despite extensive workup or no etiology found because of cursory evaluation.

Table 1. Distribution of ischemic stroke subtypes in **our study**.

Stroke Type	Lacunar	Large vessel	Other determined	Cardioembolic	Undetermined
No. of patients	168	106	15	24	80
Percentage	42.7%	26.9%	3.8%	6.1%	20.3%

Table 2. Age and sex distribution across different stroke subtypes (adapted from Yip et al127).

Characteristics	Large-artery atherosclerosis (n=106)	Lacunae (n=168)	CEI (n=24)	Stroke of other determined etiology (n=15)	All ischemic strokes	Stroke of undetermined etiology (n=80)
Men	79(74.5%)	99(58.9%)	14(58.3%)	8 (53.3%)	246(62.6%)	46 (57.5%)
Mean (SD)	60.6+ 14.3	60.7+ 11.8	58.8+ 14.6	57+ 14.5	60.5+ 13.1	59.8+14.4

Hypertension was defined as a past medical history of hypertension (whether treated or not) or electrocardiographic or echocardiographic evidence of hypertension

Diabetes Mellitus was defined as a past medical history of diabetes mellitus or sustained blood sugar elevation requiring treatment with hypoglycemic agents or insulin throughout hospitalization.

Abnormal cholesterol elevation was defined as history of high cholesterol in the past or documentation of elevated cholesterol during hospital stay.

Cardiac disease was defined as cardiac arrhythmia, valvular heart disease, ischemic heart disease, or congestive cardiac failure present on past medical history or documented during hospitalization.

Patients were worked up according to established clinical pathway, and investigations included Neuroimaging (CT or MRI), electrocardiogram, transthoracic echocardiogram, complete blood count, coagulation profile, serum electrolytes, blood urea nitrogen, creatinine, Urine detailed report, and carotid doppler ultrasonography (ischemic stroke). Selected patients underwent transesophageal echocardiogram with bubble contrast, 24 hours hotter monitoring and work up for hypercoagulable state.

All patients were evaluated by a consultant neurologist, and the data was encoded by neurology housestaff on a standardized data entry form. The data was collected during the patient's hospital stay and the patient's discharge was the end point for the purpose of this study.

The data was analyzed using SPSS 10.0 for Windows. The data is presented in means, median and percentages.

## Results

During the 22 month period, there were 596 patients enrolled in the AKU acute stroke data bank. Three hundred and ninety three of these patients suffered from ischemic stroke and 126 were diagnosed with a primary intracerebral hemorrhage. Twenty seven patients were considered not to have suffered a stroke (22 TIA, two psychogenic symptoms and one metabolic encephalopathy presenting as a stroke). An additional 50 patients with subarachnoid hemorrhage were enrolled, but excluded from analysis.

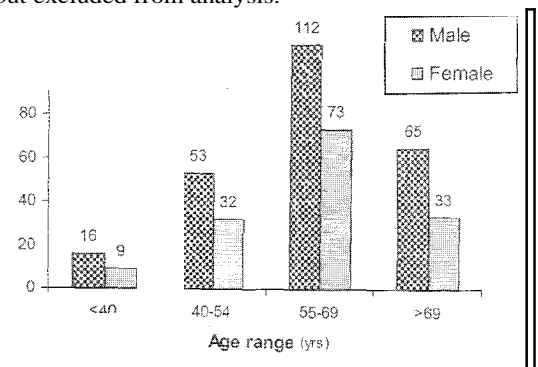


Figure. Age and sex distribution for all ischemic stroke patients

Our study focuses on the ischemic stroke group. Ii., this group, there were 246 (62.6%) men and 147(37.4%) women, male to female ration of 1.67. The mean age was 60.5 years (sd 13.1), with median of 61 years and range 15- 100 years (Figure). The frequency of various stroke subtypes is summarized in Table 1.

Hypertension was the most common risk factor (260 patients, 66.2%), followed by Diabetes (163 patients, 41.5%).

Table 3. Relative Incidences of Cerebral Infarction Subtypes Reported From Selected Stroke Registry Studies.

Study	Author	No. of patients	Large-vessel atherosclerotic	Lacunar	Embolic	Cardioembolic	Undetermined Cause
Harvard	Mohr <sup>28</sup>	579	233(40)	131 (23)	215 (37)	112(19)	---
Austin Hospital	Chambers <sup>29</sup>	580	263(45)	140(24)	---	51 (9)	126(21)
Pilot SDB	Kunitz <sup>130</sup>	708	172(24)	100(14)	200(28)	---	236(33)
CHSPs	Yatsu <sup>31</sup>	3727	1 880 (50)	---	636(17)	---	1240 (33)
Lausanne	Bogousslavsky <sup>32</sup>	891	427(48)	147(16)	---	204 (23)	74(8)
Lehigh Valley	Friday <sup>33</sup>	2386	1590 (67)	246(10)	516(22)	---	34(1)
NINCDS SDB	Sacco et al <sup>34</sup>	1273	182 (14)	337(27)	---	246(19)	508(40)
UCSD SDB	Rothrock et al <sup>35</sup>	500	88 (18)	133 (27)	---	110(22)	117(23)
SCAN IV	Yip et al, 1997	676	113 (17)	195(29)	---	133 (20)	196(29)
AKU	Syed et al, present study	---	106(26.9%)	168(42.7%)	---	24(6.1%)	80(20.3%)

Of all patients admitted with an ischemic stroke, 301 (76.6%) had either diabetes mellitus or hypertension or both. A history of previous stroke or TIA was found in 103 ischemic stroke patients (26.2%). Dyslipidemia was present in 87 patients (22.1 %).

The age and sex distribution across different stroke subtypes is shown in Table 2. There was little variability in age across the different stroke subtypes. Interestingly, patients suffering large vessel atherosclerotic strokes revealed a higher probability of being male.

### Discussion

Stroke is the second most common cause of death world wide<sup>13</sup> and the third most common cause of death in the developed world. Strokes cause over 5.5 million deaths annually<sup>14</sup> and two thirds of these occur in the developing world.<sup>15</sup>

The burden of stroke on the society is immense with emotional, financial and functional loss that is difficult to estimate. There is no cost effective curative therapy for stroke and the bulk of public health initiatives are focused on prevention. Prevention of strokes (and indeed diagnosis and therapy) requires an in-depth understanding of the stroke subtypes and etiologic factors which differ by geographic region, and even by ethnicity within the same region. The variation in stroke subtypes is of global relevance in view of the world wide migration of populations.

Large Community based stroke registries are likely to provide more accurate analysis of incidence while hospital based studies are likely to underestimate very mild and immediately fatal strokes. However, hospital based studies would be able to provide a more uniform work-up of stroke,

allowing for a more accurate analysis of stroke subtypes and etiologic factors.

Our hospital based prospective study aims to elucidate the various stroke subtypes among ischemic stroke in Pakistan. Toast criteria were chosen for determining stroke subtypes for this prospective study due to well established interphysician agreement.<sup>16</sup> To our knowledge, this is the only prospective study of stroke subtypes in Pakistan.

Hypertension is the most powerful and important modifiable risk factor for stroke.<sup>17-19</sup> An increase of the diastolic blood pressure of as little as 6 mm hg results in 36% higher risk of stroke.<sup>1-0</sup>

The prevalence of hypertension in our study is high (66.2%), and is similar to other published studies such as OXVASC (55.9%), OCSP (65.5%).<sup>21,22</sup>

Our data contrast with lower rates reported from Sweden (32%)<sup>23</sup> and Switzerland (44%).<sup>24</sup> This variability in prevalence of hypertension is well established in the multinational MONICA project.<sup>1-5</sup>

Our high prevalence of hypertension is comparable to stroke patients in other south-east Asian countries.<sup>25</sup> It underscores the need to target under treatment of major public health problems and indicates the need to incorporate treatment of hypertension into health care policy measures to reduce the morbidity and mortality of stroke.

A limitation of our study is although the study spanned over a long period of time, but due to logistical reasons, there were intervals during the study period when the patients were not recruited into the stroke data bank. However, the patients that were recruited into the data bank are representative of the stroke population admitted to our

hospital. So although our numbers may be relatively small compared to the larger stroke registries, but we are still able to derive useful information and inferences from our data.

Table 3 compares the finding of ischemic stroke subtypes in our study with other selected stroke registries.<sup>27</sup>

The lower incidence of cardioembolic stroke in our population (6.1 %) is in contrast to the rates generally noted in stroke registries, which are often above 20%. This may be due to ethnic differences such as the relatively higher incidence of lacunar strokes in our population. Additionally, higher incidence of co-morbid conditions such as hypertension, diabetes and dyslipidemias may lead to a greater proportion of cardioembolic strokes being classified into the undetermined etiology category due to the concomitant presence of 2 or more etiologic processes. Additionally, the under recognition and under treatment of hypertension and diabetes in the population could hypothetically lead to over representation of strokes etiologically related to hypertension and diabetes in our population. Our criteria for diagnosing cardioembolic stroke were strict. Over fifty percent of electrocardiograms (198/371) were abnormal, but all these patients were not considered cardioembolic strokes. Categorization as a cardioembolic required a clear abnormality such as atrial fibrillation, and the absence of features suggestive of other stroke subtypes (for example large artery atherosclerosis, and small vessel occlusion).

The most common stroke subtype was lacunar infarction. Our study reveals a much higher frequency of lacunar infarction compared to the western literature (as low as 10% (Table 3). The higher frequency of lacunar infarctions in our study is more comparable to other South East Asian countries. Other comparative studies have noted a higher frequency of lacunar infarctions in South East Asian populations compared to Caucasian populations.<sup>36</sup>

Our finding of a higher incidence of lacunar stroke confirm ethnic [variation in](#) susceptibility to different stroke subtypes in different population suggested by several studies. This propensity towards cerebrovascular disease may be partly accounted for by the risk factor profile of South Asian profile. Hyperinsulinemia may be associated with a higher risk of ischemic stroke.<sup>37-39</sup> South Asian populations (relative to Caucasians populations) have been reported to suffer from higher plasma insulin levels and insulin resistance<sup>40,41</sup> and the associated risk factors such as adverse lipid profile, and hypertension<sup>40,42,43</sup> Elevated tissue plasminogen activator has also been associated with the pathogenesis of atherothrombotic risk in South Asian stroke patients.<sup>44</sup>

There is a paucity of data on ischemic stroke in Pakistan. A medline search revealed only two references to studies examining epidemiology of stroke in urban

Pakistan.<sup>45,46</sup>

One retrospective analysis from Pakistan revealed a prevalence of hypertension of 50.2% (304/606) patients with stroke (both ischemic and hemorrhagic), but prevalence in ischemic stroke is not reported.<sup>46</sup> The other study looked at young stroke, and in this selected population found a prevalence of hypertension of 43% (51/118). These studies support a strong role for hypertension in ischemic stroke in our population. We further hypothesize that our population may be susceptible to lacunar infarction, compared to other ischemic stroke subtypes, in part due to the high burden of hypertension.

Interestingly, patients with large artery atherosclerosis are significantly more likely to be male (74.5%) than female (25.5%) (Table 2). This finding may be attributable to difference in risk factors such as smoking and diet across the genders in our population.

In conclusion, the stroke subtypes in our Population differ from those typically reported in the Western literature. This finding confirms for our local population, the influence of ethnic and geographic variables suggested by other studies.<sup>47-49</sup>

Diabetes and hypertension are the strongest risk factors for lacunar infarction, and they are common amongst patients with ischemic stroke in our population. The high frequency of lacunar infarction amongst ischemic stroke most likely represents susceptibility to the cumulative effect of the frequency and the severity of hypertension, diabetes and other risk factors in our population. We recommend that any national stroke prevention program should take into account the differences in ischemic stroke Subtypes in our local population.

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## References

- Frederickson JL, Iahnke HK, Bulfinch EW. Differences in Stroke between white, hispanic, and native american patient: the Barrow Neurological Institute Stroke database. *Stroke* 1998;29:29-33.
- Feldmann E, Daneault N, Kwan F, et al. Chinese-ethnic differences in the distribution of occlusive cerebrovascular disease. *Neurology* 1990;40:1-4.
- Liu LH, Caplan LR, Kwan E, et al. Racial differences in ischemic cerebrovascular disease: clinical and magnetic resonance angiography correlations of white and Asian patients. *Stroke Cerebrovasc Dis* 1996;6:79-84.
- Luong SY, Ng TFIK, Yuen ST, et al. Pattern of cerebral atherosclerosis in Hong Kong Chinese: severity in intracranial and extracranial vessels. *Stroke* 1994;24:779-86.
- Liu HM, Tu YK, Yip PK, et al. Evaluation of intracranial and extracranial carotid stenosis-occlusive diseases in Taiwan Chinese patients with MR angiography: preliminary experiences. *Stroke* 1996;17:650-3

6. Tomita T, Miltara H. Cerebral angiographic study oil C.VD. in Japan. *Angiology* 1972;23:228-39.
- Mitsuyama Y, Thompson LR, Hayashi T, et al. Autopsy study of cerebrovascular disease in Japanese men who lived in Hiroshima, Japan, and Honolulu, Hawaii. *Stroke* 1979;10:389-95.
8. Gorelick P13, Caplan LR, Hier DB, et al. Racial differences in the distribution of anterior circulation occlusive disease. *Neurology*. 1984;34:54-59.
9. Sacco RL, Kargman DE, Gu Q, et al. Race-ethnicity and determinants of intracranial atherosclerotic cerebral infarction: the Northern Manhattan Stroke Study. *Stroke* 1995;26:14-20.
10. Caplan LR, Gorelick PB, Hier DB. Race, sex and occlusive cerebrovascular disease: a review. *Stroke* (1986;17:648-55.
11. Hatano S. Experience from a tntnicenter Stroke Registry: A Preliminary Report *Bull World Health Organ* 1976;54:541-53.
12. Adams HP Jr, Bendrixen BH, Kappelle LJ, et al. Classification of subtype of acute ischemic stroke. Definition for use in a multicenter clinical trial. *Stroke* 1993;24:35-41.
13. Sarti C, Rasterryte D, Cepaitis Z, et al. International trends in mortality from stroke. 1968 to 1994. *Stroke* 2000;31:1588-601.
14. World Health Organization. *The evorld health report 2000*. Geneva: WHO, 2000.
15. World Health Organization. *The world health report 1998*. Geneva: WHO, 1998.
16. Gorden DL, Bendixen BH, Adams HP Jr, et al. Interphysician agreement in the diagnosis of subtypes of acute ischemic stroke: implications for clinical trial. *Neurology* 1993;43:1021-27.
17. Collins R, Peto R, MacMahon S, et al. Blood Pressure, stroke and coronary heart disease, part 2: effects of short-teen reductions in blood pressure: overview of randomised drug trials in their epidemiological context. *Lancet* 1990;335:827-38.
18. Garaway WM. The changing pattern of hypertension and tile declining incidence of stroke. *JAMA* 1987;258:214-17.
19. MacMahon S, Peto R, Cutler J, et al. Blood pressure, stroke, and coronary heart disease, part I: effects of prolonged differences in blood pressure: prospective observational studies corrected for tile regression dilution bias. *Lancet* 199U35:765-74.
20. MacMahon S. Tire effects of antihypertensive drug treatment on the incidence of stroke and of coronary heart disease. *Clin Exp Hypertens A* 1989;11:807-23.
21. Bamford J, Sandercock P, Dennis M, et al. A prospective study of acute cerebrovascular disease in tile conurnunity: the Oxfordshire Community Stroke Project 1981-86, 1: methodology, demography and incident cases of first-ever stroke. *J Neurol Neurosurg Psychiatry* 1988;51:1373-80.
22. Sander cock PAG, Warlow CP, Price SM. Incidence of stroke in Oxfordshire: first year's experience: Oxfordshire Community Stroke Project. *BMJ* 1983;287:713-17.
23. Jerntorp P, Berglund G. Stroke registry in Malmo, Sweden. *Stroke* 1992;23:357-61.
24. Bougousslavsky J, MCHC GV, Regli F. The Lausanne Stroke Registry. *Stroke* 1988;19:1083-92.
25. Thorvaldsen P Krmlasnaa K, Rajakangas AM, et al. Stroke Trends in tile WHO MONICA Project: *Stroke* 1997;28:500-6.
26. Venketasubramanian N. Tile epidemiology of stroke in ASEAN Countries - *Neurol J Southeast Asia* 1998;3:9-14.
27. Yip PK, Jeng JS, Lee TK, et al. Subtypes of ischemic stroke: a hospital-based stroke registry in Taiwan (SCAN-IV). *Stroke* 1997;28:2507-12.
28. Moln JP, Caplan LR, Melski JW, et al. The Harvard Cooperative Stroke Registry: a prospective registry. *Neurology* 1978;28:754-62.
29. Chambers BR, Dorman GA, Baldin PF. Patterns of stroke: an analysis of the first **700 consecutive admissions to the Austin hospital stroke unit**. *Aust NZ J Med* 1983;13:57-64.
30. Kunitz SC, Gross CR, Heyman A, et al. The pilot stroke data bank: definition, design and data. *Stroke* 1984;15:740-6.
31. YatSU FM, Becker C, McLeroy KR, et al. Community hospital-based stroke programs: North Carolina, Oregon and New York, I: goals, objectives and data collection procedures. *Stroke* 1986;17:276-84.
32. Bogousslavsky J, Melle GV, Regli F. The Lausanne stroke registry: analysis of 1,000 consecutive patients with first stroke. *Stroke* 1988;19:1083-92.
33. Friday G, Lai SM, Alter M, et al. Stroke in the Lehigh Valley: racial/ethnic differences. *Neurology* 1989;39:1165-8.
34. Sacco RL, Eilenberg JH, Mohr JP, et al. Infarcts of undetermined cause: tile NINCDS Stroke Data Bank. *Ann Neurol* 1989;25:382-390.
35. Rothrock JF, Lyden PD, Brody ML, et al. An analysis of ischemic stroke in an urban southern California population: tile University of California, San Diego\_ stroke data bank. *Arch intern Med* 1993;153:619-24.
36. Wai Keong NG, Khean Jin GOH, George J., et al. A comparative study of stroke subtypes between Asian and Caucasians in two hospital based stroke registries *Neural J Southeast Asia* 1998;3:19-26.
37. Pyorala M, Miettinen H, Laakso M, et al. Hyperinsufnemia and tile risk of stroke in healthy middle-aged men: the 22-year follow-up results of the Helsinki policemen study. *Stroke* 1998;29:1860-6.
38. Pyorala M, Miettinen H, Halonen P, et al. Insulin resistance syndrome predicts the risk of coronary heart disease and stroke in healthy middle-aged men: tire 22-year follow-up results of the Helsinki policemen study. *Arterioscler Thromb Vase Biol* 1999;20:538-44.
39. Lakka HM, Lakka TA, Tuomilelno J, et al. Hyper-insulinemia and the risk of cardiovascular death and acute coronary and cerebrovascular events in men: the Kuopio ischaemic heart disease risk factor study. *Arch Intern Med* 2000;160:1160-8.
40. Dhawan J, Bray CL, Warburton R, et al. Insulin resistance, high prevalence of diabetes, and cardiovascular risk in immigrant Asians: genetic or environmental effect? *Br Heart J* 1994;72:413-21.
41. McKeigue PM, Ferie JE, Pierpoint T, et al. Association of earl]-onset coronary heart disease in South Asian men with glucose intolerance and hyperinsulinemia. *Circulation* 1993;87:152-61.
42. McKeigue PM, Shah B, Marmot MG. Relation of central obesity and insrdin resistance with high diabetes prevalence and cardiovascular risk in South Asians. *Lancet* 1991;337:382-6.
43. McKeigue PM, Marmot MG, Syndercombe Court YD, ct al, Diabetes, hyperinsulinaemia and coronary risk factors in Bangladeshis in east London. *Br Heart J* 1988;60:390-6.
44. Kam K, Carlo AJ, Young J, et al. Insulin resistance and elevated levels of tissue plasminogen activator in first-degree relafms of South Asian patients with ischemic cerebrovascular disease. *Stroke* 2001;32:1069-73.
45. Razzaq AA, Khan BA, Baig SM. Isehemic stroke in young adults of South Asia. *J Pak Med Assoc* 2002;52:417-22.
46. Vohra EA, Ahmed WU, Ali M. Aetiology and prognostic factors of patients admitted for stroke. *J Pak Med Assoc* 2000;50:234-6.
47. Shi F, Hart RG, Sherman DG, et al. Stroke in the People's Republic of China *Stroke* 1989;20:1581-5.
48. Kay R, Woo J, KreeL L, et al. Stroke subtypes among Chinese living in Hong Kong: the Shatin stroke registry. *Neurology* 1992;42:985-7.
49. Fields WS, North RR, Hass WK, et al. Joint study of extracranial arterial occlusion as a cause of stroke. 1. organization of study and survey of patient population. *JAMA* 1968; 203:153-8.