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Introduction
The term viral or aseptic meningitis refers to a meningitis for which an etiological agent is not apparent after bacterial culture of cerebrospinal fluid (CSF)[1]. Aseptic meningitis may be caused by a variety of agents[1,2] including enteroviruses, lymphocytic choriomeningitis virus, mumps and measles virus. The disease may be mimicked by inadequately treated pyogenic meningitis, tuberculous, cryptococcal and cerebrovascular syphilis. The syndrome is characterised by acute onset, fever, headache and stiff neck brought on by inflammation of the tissues that cover the brain and spinal cord. Diagnostic work-up of aseptic meningitis is often incomplete, and an etiological agent is identified in less than half of all cases. Aseptic Meningitis maybe a serious condition and can be very debilitating but is only rarely fatal.

The 1981 infectious disease regulations specifies that as soon as a medical practitioner becomes aware of, or suspects that a patient is suffering from or is a carrier of particular infectious diseases, he/she is required to transmit a written notification to the relevant Medical Officer in his/her health board area. Viral meningitis is one of these listed notifiable diseases. Although national notifications of viral meningitis in Ireland have increased between 1997 and 2001 (32 and 161 respectively), anecdotal evidence suggests the true number of infections is seriously underestimated/under-reported. The aim of this study therefore was to quantify the burden of viral meningitis on hospitals from 1997 to 2001 in the NEHB and compare the results to statutory notifications for the same period.

Methods
HIPE (Hospital In-Patient Enquiry System) is the principal source of data on discharges from acute hospitals in the Republic of Ireland and is the responsibility of The HIPE and NPRS Unit at the Economic and Social Research Institute (who kindly provided the dataset for this study). All hospital in-patient admissions from 1997 to 2001 with a principal diagnosis relating to infectious and parasitic diseases (ICD codes 001 - 139) involving residents from the NEHB (Cavan, Louth, Meath & Monaghan) were extracted from the HIPE system. All notifiable infectious diseases (based on the 1981 infectious disease regulations) were identified and all viral meningitis cases (ICD codes 047 & 049.0) were then extracted.

Data were analysed in the statistical package, JMP. Denominator data for population based rates correspond to published census results from the Central Statistics Office (CSO). For intercensal years, linear interpolation has been used. Incidence rates were calculated as the number of cases per 100,000 NEHB residents. Rates were age adjusted using the standard European population as a reference population.

In some cases patients may have had repeat hospitalisations for the same condition. In these cases duplicates were removed based on a first occurrence per patient basis. Patients which were re-admitted to the same hospital with the same principal diagnosis were identified based on medical record number. Hospital transfers were identified based on the patients date of birth, sex, residence, diagnosis and a hospital admission date within one day of discharge from a previous hospital.

Data for viral meningitis notifications, involving NEHB residents, were kindly provided by the National Disease Surveillance Centre (NDSC).

Results
A total of 265 NEHB residents were admitted to hospital with a principal diagnosis of viral meningitis on 271 occasions during the 5-year period between 1997 and 2001 (Table 1). The majority of these patients (92.1%) presented at the five NEHB hospitals, namely Our Ladys Hospital Navan, Our Lady of Lourdes Hospital Drogheda, The Louth County Hospital, Cavan General Hospital and Monaghan General Hospital. A further 6.4% of patients presented at Dublin hospitals and the remaining 1.5% presented at various hospitals throughout the country. A principal diagnosis of Viral Meningitis (Not Otherwise Specified) was recorded for the majority of patients (262 patients, 98.8%). It was not possible to document the specific virological examinations carried out or detail further the pathogens identified as this information was not available in the HIPE dataset.

Table 1. Summary Data for Viral Meningitis Cases (1997 to 2001)

	1997	1998	1999	2000	2001	Total
Total hospitalisations for VM*	21	20	19	100	111	271
Total number of patients	21	19	18	99	108	265
Total number of VM* notifications for NEHB residents	4	3	8	12	11	38
Total number of national VM* notifications	32	32	27	98	161	350
Average bed days for VM* hospitalisations/year	5.48	7.25	5.26	4.13	4.15	4.5
Total bed days for VM* hospitalisations	115	145	100	413	461	1234
Age standardised incidence rate/100,000 population	6.11	5.85	5.4	29.6	32.2	
Total hospital admissions for NEHB residents	45130	44812	49682	51798	54339	245761
% VM* /total admissions for NEHB residents	0.05%	0.04%	0.04%	0.19%	0.20%	0.11%
Total infectious disease hospitalisations/year	993	1223	1172	1564	1685	6637
% VM* / total infectious disease hospitalizations/year	2.1%	1.6%	1.6%	6.4%	6.6%	4.1%

*** VM** Viral Meningitis

Viral meningitis admissions by NEHB residents rose dramatically between 1997 and 2001 with 21 hospitalisations in 1997 compared to 111 hospitalisations in 2001 (Table 1). This represents an increase of 429% in viral meningitis hospitalisations during this period. This increase was reflected in all of the NEHB hospitals and various other hospitals that NEHB residents attended outside the region. Hospitalisations due to viral meningitis as a percentage

of infectious disease hospitalisations increased significantly from 2.11% in 1997 to 6.6% in 2001 ($p < 0.0001$). Indeed, the percentage of hospitalisations due to viral meningitis out of the total hospitalisations for NEHB residents rose from 0.05% to 0.2% during the study period (Table 1). The age standardised viral meningitis incidence rate rose significantly from 6.11 (95% CI 3.45 8.77) per 100,000 NEHB residents in 1997 to 32.2 (95% CI 26.1 38.3) per 100,000 NEHB residents in 2001 (Figure 1). Thus, the increase in viral meningitis hospitalisations cannot be attributed to changes in population structure. The highest number of hospitalisations occurred in June 2000 followed by July 2001. Indeed 48% of all cases occurred during the months of June, July and August.

A profile of these viral meningitis patients showed that there were significantly more males than females (62.3% versus 37.7%, $p < 0.0001$). This discrepancy in gender is particularly evident in the 0 4 year age group and the 5 9 year age group (Table 2). The mean age of the patients was 16.3 years (95% CI 14.5 18.1) however the most common age group was 5 to 9 year olds (22.3% of all cases). In fact, children under 10 accounted for 42.3% of all hospital admissions for viral meningitis in the 5-year study period.

Table 2. Age Specific Viral Meningitis Incidence Rate by Sex and Age Group

Age group	Rate/100,000 pop	
	Male	Female
0 to 4	63.5	29.5
5 to 9	65.6	29.8
10 to 14	33.6	25
15 to 19	27.6	15.6
20 to 24	6.4	21.8
25 to 29	12.1	11.1
30 to 34	20.4	11.1
35 to 39	10.7	10.5
40 to 44	10.8	3.8
45 to 49	7.7	0
50 to 54	6.3	4.6
55 to 59	2.8	3
60 to 64	0	6.9
65 to 69	0	0
70+	0	1.4

The majority of viral meningitis patients (78.9%) had a procedure carried out while in hospital. The most common principal procedure was lumbar puncture (189 patients, 71.3%), followed by a CAT brain scan (12 patients, 4.5%). Although, 2.6% of patients had an injection of antibiotics listed as one of their procedures, the HIPE dataset provided no detailed information on the specific antibiotics or dosage prescribed. The average number of bed days taken up over the 5-year period was 4.5 days (95% CI 4.2 4.9) which ranged from stays of less than 1 day to 18 days. A total of 115 bed days were taken up by viral meningitis patients in 1997 but this rose dramatically to 413 in 2000 and 461 in 2001 (Table 1). The total number of bed days taken up by this cohort over the 5-year period was 1,234 days. The majority of patients were discharged home (98.9%).

Notifications for viral meningitis in the North Eastern Health Board between 1997 and 2001 totalled 38 (Table 1) ranging from 4 in 1997 to 11 in 2001. Of these 9 were male, 4 were female and 25 did not have gender recorded. The highest number of notifications occurred in June 2000 (6 notifications out of 12 for 2000) followed by August 2001 (5 notifications out of 11 for 2001). Indeed during the 14-year period from 1988 to 2001 the highest number of notifications for any one-year for the NEHB occurred in 2000 with 12 cases reported. Comparison of these notifications over time with viral meningitis hospitalisations (Figure 2) demonstrates the discrepancy in the number of notified cases versus hospitalised cases (38 versus 265 respectively). Assuming all notified cases were hospitalised, this represents an overall notification rate of 14.3%. Furthermore, this notification rate did not change significantly over the 5-year study period. However, it is interesting to note that the notification pattern in 2000 and 2001 broadly follows the pattern of viral meningitis hospitalisations during the same period albeit at a much reduced level (Figure 2).

Discussion

This study demonstrates that the number of NEHB residents hospitalised for viral meningitis increased significantly between 1997 and 2001, and that the majority of these cases were not notified. This study also highlights the increase in the disease burden of viral meningitis: there was a substantial increase in the total number of bed days per year taken up by viral meningitis patients during 1997 to 2001 even though the average number of bed days per patient remained constant. Furthermore, children under 10 accounted for 42% of viral meningitis hospitalisations involving NEHB residents between 1997 and 2001. Hospitals need to be able to cope with the changes in the dynamic pattern of infectious disease types from year to year. The importance of studies like this lies in the necessitity for policy makers to be aware of the trends in infectious diseases in order to allow for flexibility within the healthcare system and to deal with the concomitant resource implications.

The majority of clinically significant viral meningitis cases are likely to be admitted to hospital, as symptoms are similar to the more serious bacterial form of meningitis. Hospital admissions should be a relatively accurate indicator of the incidence of this disease. As there has been no change in the coding practice for viral meningitis between 1997 and 2001 (personnel communication HIPE & NPRS Unit) and as all hospitals within the NEHB (which accounted for 92.1% of all admissions) showed dramatic increases in viral meningitis cases during 2000 and 2001, it is extremely unlikely that a HIPE coding issue is accountable for the rise in hospitalisations during the study period. Furthermore, the increase in viral meningitis hospitalisations involving NEHB residents during 2000 and 2001 has also coincided with an increase in both national[3] and international[4, 5, 6, 7, 8] notifications. There has been a large increase in national notifications for viral meningitis between 1997 and 2001 (32 versus 161 respectively[3]). At an international level, an increase in notifications of viral meningitis in 2000 and 2001 in England and Wales[4, 5] (where the reporting system relies upon both clinician reporting and laboratory results) was associated with an increase in Echo Virus type 30. There were also outbreaks of viral meningitis in Germany[6] and Spain[7, 8] in 2000. Clearly, the recent increases in viral meningitis cases and the associated morbidity and mortality are a cause for concern.

CSF microscopy and cultures are normally required to differentiate between bacterial and viral meningitis so it is not surprising to note that lumbar puncture was the primary procedure performed in 71.3% of patients diagnosed with viral meningitis. The average length of hospital stay for this cohort was 4.5 days perhaps because of the severity of symptoms but more likely due to the need to exclude more serious causes of meningitis.

The underreporting of viral meningitis hospitalised cases in NEHB residents is alarming. If this level of under-reporting is similar in other health boards, then the national figures for viral meningitis are also grossly underestimated. The disease burden of viral meningitis and perhaps other diseases goes essentially unnoticed and this has implications for both notifiable infectious disease policy and surveillance in Ireland. This under-reporting casts doubt on the effectiveness of the notification process as a real-time surveillance tool and an early warning system for outbreaks. Various studies have suggested that a lack of knowledge of the list of statutory notifiable diseases and a lack of understanding of the importance of notification contributes to poor clinician reporting[9,10]. Perhaps with a new notifiable disease list (introduced on the 1st of January 2004), the inclusion of microbiology laboratories as notifiers and a national computerised infectious disease reporting system in preparation, now is also the time to offer education and feedback to relevant healthcare workers on the importance of the notification process for prompt public health action and for the monitoring of disease incidence in the Irish population. Finally, studies like this one may provide a baseline for comparing the effectiveness of the new reporting system.

Addendum

Since this paper was submitted for publication, the 2002 HIPE data became available. In 2002 there were 34 NEHB residents hospitalised with a principal diagnosis relating to viral meningitis. However there were only 4 cases of viral meningitis notified for NEHB residents which gives a meagre notification rate of 12%.

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