Tetanus in the elderly—An important preventable disease in Australia

Helen E. Quinn *, Peter B. McIntyre

National Centre for Immunisation Research and Surveillance of Vaccine Preventable Diseases (NCIRS), The Children’s Hospital at Westmead and the University of Sydney, Locked Bag 4001, Westmead, NSW 2145, Australia

Received 29 May 2006; received in revised form 25 September 2006; accepted 28 September 2006

Available online 12 October 2006

Abstract

Notification trends from countries with well-established immunisation programs show increasing tetanus cases among the elderly, corresponding to seroepidemiologic data showing declining immunity with advanced age. We examined Australian trends in tetanus to review the likely value of routine funded immunisation at 65 years. Since 1993, 62% (36/58) of notifications, 44% (67/151) of hospitalisations and 83% (10/12) of deaths were in people aged over 65 years. Taking into account higher vaccine coverage at 65 years, versus the current recommended age in Australia of 50 years, we estimate that routine funded tetanus vaccine would prevent 9% more hospitalisations and 28% more deaths than the most favourable outcome from the current unfunded recommendation at 50 years. This is likely to be applicable to other industrialised countries.

Crown Copyright © 2006 Published by Elsevier Ltd. All rights reserved.

Keywords: Tetanus; Immunisation; Policy

1. Introduction

In Australia and most industrialised countries, tetanus is now sporadic and uncommon, with a recent reported incidence per million population of 0.16 in the United States [1], 0.1–0.2 in Australia [2] and 0.7 in New Zealand [3]. Notified incidence is dependent on reporting practices of medical practitioners and hospitals, as laboratory isolates are seldom available. Deaths and hospitalisations due to tetanus are important independent indicators of total morbidity, but less examined. Although coding of deaths and hospitalisations is likely to be imperfect, it is presumably consistent over time and in view of the deficiencies in the notification data, to add important information. Available data show an increasing proportion of tetanus cases among the elderly in industrialised countries [3–5]. Seroepidemiologic showing a progressively lower prevalence of levels of tetanus antibody thought to be protective in age groups over 50 years [6–12] have led to a tetanus vaccine booster being recommended at 50 years of age in Australia and Canada [13,14]. However, Canadian data showing poor uptake among adults [15] are likely to apply to similar countries. In contrast, influenza and polysaccharide pneumococcal vaccines, routinely given to persons over 65 years of age in many industrialised countries, have high uptake [16–18].

We examined trends in deaths from tetanus over a 40 year period and in hospitalisations and notifications over a 9 year period in Australia to estimate the likely impact of routine tetanus immunisation at 65 years and older on deaths and hospitalisations compared with the currently recommended age point of 50 years.

2. Methods

Three sources of routinely collected surveillance data were used—notification data from the National Notifiable Diseases Surveillance System (NNDSS), hospitalisation data from the Australian Institute of Health and Welfare (AIHW), National Hospital Morbidity Database and death data from the AIHW National Hospital Mortality Database.

* Corresponding author. Tel.: +61 2 9845 1425; fax: +61 2 9845 1418. E-mail address: helenq@chw.edu.au (H.E. Quinn).
2.1. Notifications

The case definition used in Australia for notification of tetanus is as follows: a clinically compatible illness without other apparent cause and with or without laboratory evidence of the organism [19]. Disease notification data for cases with an onset between January 1, 1993 and December 31, 2002 are included in this report. Notification data are presented and reported by date of onset.

2.2. Hospitalisations

The AIHW National Hospital Morbidity Database has received data about patients admitted to all public and private hospitals in Australia since 1993. Cases with separation dates between July 1, 1993 and June 30, 1998 with an International Classification of Diseases, ninth revision (ICD-9) code of 037 (tetanus) or 771.3 (tetanus neonatorum) and cases with separation dates between July 1, 1998 and June 2002 with an ICD-10 code of A33 (tetanus neonatorum), A34 (obstetrical tetanus) or A35 (other tetanus) were examined.

2.3. Deaths

Data were available from the AIHW Mortality Database, for deaths registered between January 1, 1964 and December 31, 2003. Although multiple causes of death can be recorded, only those where tetanus was listed as the underlying cause of death were examined.

2.4. Calculations

2.4.1. Population estimates

All rates were calculated using Australian Bureau of Statistics mid-year estimated resident populations and are presented as annual rates or average annual rates per million total population or population in age, sex or geographical subgroups, as appropriate. Average annual rates were calculated by dividing the total number of cases for the period of investigation by the sum of the population for the same period. For notification and hospitalisation data, the mid-year population estimate for the first half of the financial year was used as the denominator (e.g., the 1993 mid-year population estimate for the first half of the financial year was used to calculate rates for 1993/1994).

Remoteness was classified using the Australian Standard Geographical Classification system [20], collapsed into two categories; metropolitan (major cities) and non-metropolitan (inner regional, outer regional, remote and very remote).

Incidence rate ratios (IRR) were calculated to compare notification rates by gender and to compare mortality rates in different time periods. 95% confidence intervals (CI) and p values were calculated for each IRR using a standard procedure in EpiBasic, University of Aarhus Denmark.

2.4.2. Cases preventable by vaccination at 50 and 65 years

The number of hospitalisations and deaths prevented by immunisation were calculated as follows. We used the number of hospitalisations and deaths in the period 1993–2004 by age group (Table 2) and then applied estimates of vaccine coverage and efficacy to these cases. Vaccine coverage was calculated as incremental, that is, the existing unfunded recommendation at 50 years with the addition of routine funded immunisation at 65 years. At 50 years, an estimated 48% uptake for tetanus vaccine was used, based on the proportion of persons aged 45–64 years in Canada reporting receipt of tetanus vaccine within 10 years [15]. At 65 years, 85% coverage for tetanus vaccine was used, based on the reported uptake of influenza vaccine at this age in Australia, assuming that this would also apply to a tetanus booster if funded for routine use [16]. It was assumed for both age groups that immunisation would provide 95% protection against hospitalisation or death from tetanus for the remainder of the person’s life. Based on previous studies that have investigated the vaccination status of tetanus cases [1,5], we made an assumption for the above calculations that cases were unvaccinated.

2.5. Notification and hospitalisation disparity

Although notification of tetanus is mandatory [19], reviews of Australian disease data have shown a discrepancy in the number of reported tetanus cases notified to health authorities and hospitalisations, principally due to a combination of under-reporting, together with multiple hospital admissions for the same case and coding errors [2]. This has occurred for other diseases such as pertussis [21] and epiglottitis [22].

Multiple admissions for a single tetanus episode were identified in this study where possible, when date of birth and/or age, gender and state of residence matched for consecutive dates of separation and admission. Cases so identified had the lengths of stay combined, as in similar studies of tetanus incidence [5]. Among cases where the tetanus code was not the principal diagnosis (the diagnosis chiefly responsible for the admission of the patient to hospital), 40% had rehabilitation codes recorded as principal diagnoses and were primarily elderly. We felt that these were likely to represent secondary and in some cases tertiary admissions for a single tetanus case, in the context of recovery after illness. Some but not all of these were identified as multiple admissions using the method described above. Thus, to provide a conservative estimate of hospitalisations, eligible cases were limited to those where a tetanus code was listed as the principal diagnosis. Based on the absence of infant notifications for tetanus, hospitalisations recorded as neonatal tetanus were considered likely coding errors and were excluded from the analysis. There were no recorded cases of obstetrical tetanus (A34). Further examination of the validity of hospitalisation codes from direct examination of hospital records was outside the scope of this study.
Table 1
Average annual tetanus notification and/or hospitalisation rates, by country

<table>
<thead>
<tr>
<th>Country</th>
<th>Rate a</th>
<th>Rate in elderly b</th>
<th>Data source</th>
<th>Period analysed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>0.35</td>
<td>2.14</td>
<td>Notifications</td>
<td>July 1993–June 2002</td>
</tr>
<tr>
<td></td>
<td>0.91</td>
<td>4.27</td>
<td>Hospitalisations</td>
<td>July 1993–June 2002</td>
</tr>
<tr>
<td>Canada</td>
<td>0.13</td>
<td>–</td>
<td>Notifications</td>
<td>1991–2000</td>
</tr>
<tr>
<td>England and Wales</td>
<td>0.2</td>
<td>0.66</td>
<td>Hospitalisations</td>
<td>1984–2000</td>
</tr>
<tr>
<td>Italy</td>
<td>2.0</td>
<td>8.0</td>
<td>Notifications</td>
<td>1991–2000</td>
</tr>
<tr>
<td>New Zealand</td>
<td>0.7</td>
<td>3.0</td>
<td>Notifications</td>
<td>1991–2000</td>
</tr>
<tr>
<td></td>
<td>1.9</td>
<td>–</td>
<td>Hospitalisations</td>
<td>1981–2000</td>
</tr>
<tr>
<td>United States</td>
<td>0.16</td>
<td>0.35</td>
<td>Notifications</td>
<td>1998–2000</td>
</tr>
</tbody>
</table>

a Per million population.
b Per million population. This rate was calculated for persons aged 65 years and over in all countries, except the United States where it was calculated for persons aged 60 years and over.

3. Results

3.1. Tetanus incidence

There were 58 notifications of tetanus between 1993 and 1994 and 2001/2002, an annual notification rate of 0.21–0.56 per million population, with an average annual incidence of 0.35 cases per million, similar to notification rates reported by other countries (Table 1). In comparison, after correction for presumed multiple admissions, there were 151 cases with tetanus recorded as the primary cause for hospitalisation, an annual rate between 0.67 and 1.4 per million population, with an average annual hospitalisation rate of 0.91 per million (Table 1).

Hospitalisations for tetanus were two to five times greater than notifications in each year. Fifty-one (88%) of the tetanus notifications could be matched to hospitalisations.

3.2. Tetanus cases by location

The average annual notification and hospitalisation rates were higher for cases from areas classified as non-metropolitan (0.43 and 0.88 per million population, respectively), than in metropolitan areas (0.23 and 0.61 per million population, respectively).

3.3. Tetanus cases by age and gender

Both the notification and hospitalisation data indicated that tetanus is primarily a disease of the elderly. Eighty-six percent (50/58) of notifications were in people aged over 50 years, 62% (36/58) were in those aged 65 years and over and 52% (30/58) were in persons 70 years and over. Sixty-five percent (98/151) of hospitalisations were in people aged over 50 years, 44% (67/151) were in those aged 65 years and over and 40% (60/151) were in those aged 70 years and over (Fig. 1 and Table 2). This pattern was consistent over the analysed period. There was no relationship between the number of hospitalisations in each age group and changes in ICD coding during the study period. Among persons over 70 years, the average annual notification rate was significantly higher for females than for males (IRR = 2.3; 95% CI = 1.0–6.4). In other age groups, there was no difference in notification or hospitalisation rates by gender (Fig. 1). One notification and two hospitalisations were recorded for children less than 5 years of age, with at least one of these children unvaccinated and the subject of an individual case report [23]. Similar proportions of hospitalised cases aged under and over 70 years could be linked to notifications (33% versus 35%; \( p = 0.79 \)).

Fig. 1. Age group/sex specific average annual notification (a) and hospitalisation (b) rates. Based on notifications of tetanus with an onset date between July 1, 1993 and June 30, 2002 and hospitalisations of tetanus with a separation date between July 1, 1993 and June 30, 2002. The cumulative percentage of notifications (a) and hospitalisations (b) is also shown.
Table 2
Summary of the notifications, hospitalisations and deaths attributed to tetanus in Australia between 1993 and 2003, by age group

<table>
<thead>
<tr>
<th>Number of persons (%)</th>
<th>&lt;50 years</th>
<th>50–64 years</th>
<th>65–70 years</th>
<th>&gt;70 years</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Notifications (1993–2002)</td>
<td>8 (14)</td>
<td>14 (24)</td>
<td>6 (10)</td>
<td>30 (52)</td>
<td>58 (100)</td>
</tr>
<tr>
<td>Hospitalisations (1993–2002)</td>
<td>53 (35)</td>
<td>31 (21)</td>
<td>7 (5)</td>
<td>60 (40)</td>
<td>151 (100)</td>
</tr>
<tr>
<td>Deaths (1993–2002)</td>
<td>1 (8)</td>
<td>1 (8)</td>
<td>0 (0)</td>
<td>10 (83)</td>
<td>12 (100)</td>
</tr>
</tbody>
</table>

3.4. Tetanus morbidity and mortality

The median length of stay in hospital was 10 days. This varied substantially with age, such that median length of stay in people aged 70 years and over was 28 days, whereas in people aged less than 70 years it was 5 days. The average annual number of deaths from tetanus declined from 12.8 in the 1960s to 1.5 in the 1990s. This has been accompanied by a progressive increase in the proportion of deaths among people aged 70 years and over ($\chi^2$ for trend: $p < 0.001$; Fig. 2), with this age group now responsible for most deaths from tetanus. Compared to the 1960s, tetanus mortality rates in the 1990s decreased in the 30–49 year age group by 94% (IRR = 0.06; 95% CI = 0.01–0.27) and by 95% in the 50–69 year age group (IRR = 0.05; 95% CI = 0.01–0.15). The tetanus mortality rate also decreased to a lesser degree in the 70 years and over age group (IRR = 0.10; 95% CI = 0.04–0.23; Table 3). Prior to the 1980s, average annual tetanus mortality rates were higher in males, but since then higher mortality rates have been recorded in females.

3.5. Cases of preventable tetanus

With the assumptions described in the methods (vaccine uptake 48%, vaccine effectiveness 95%) the current recommendation of a tetanus-containing booster at 50 years of age would have prevented 46% (45/98) of hospitalisations and 45% (5/11) of deaths occurring over the age of 50 years. In comparison, routine vaccination at 65 years (vaccine uptake of 85%, effectiveness 95%), with no tetanus booster at 50 years, would have prevented 55% (54/98) of all hospitalisations and 73% (8/11) of all deaths occurring over the age of 50 years.

4. Discussion

Tetanus is a severe disease and as infection does not confer immunity, can only be prevented by adequate immunisation. Cases of tetanus are still occurring in Australia and other industrialised countries with high immunisation rates, more than 50 years after the introduction of effective vaccines. The incidence of tetanus hospitalisation in Australia over the past decade of 0.4–0.9 cases per million population is more than three-fold higher than comparable reports from England, Canada and the United States [1,5,24], but similar to a recent report from New Zealand [3].

Table 3
Tetanus mortality between January 1, 1964 and December 31, 2003, by age group and sex

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Ratea</td>
<td>N</td>
<td>Ratea</td>
<td>N</td>
<td>Ratea</td>
</tr>
<tr>
<td>0–9</td>
<td>Male</td>
<td>8</td>
<td>1.12</td>
<td>1</td>
<td>0.08</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>1</td>
<td>0.15</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>10–29</td>
<td>Male</td>
<td>9</td>
<td>0.78</td>
<td>3</td>
<td>0.12</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>1</td>
<td>0.09</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>30–49</td>
<td>Male</td>
<td>9</td>
<td>1</td>
<td>0.23</td>
<td>1</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>2</td>
<td>0.24</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>50–69</td>
<td>Male</td>
<td>12</td>
<td>2.04</td>
<td>12</td>
<td>1.01</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>12</td>
<td>2</td>
<td>11</td>
<td>0.89</td>
<td>4</td>
</tr>
<tr>
<td>&gt;70</td>
<td>Male</td>
<td>7</td>
<td>4.65</td>
<td>11</td>
<td>3.70</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>16</td>
<td>7.03</td>
<td>17</td>
<td>3.67</td>
<td>11</td>
</tr>
</tbody>
</table>

* Average annual age/sex-specific rate per million population.
The discrepancy between tetanus notifications and hospitalisations observed in this study, is likely to be primarily related to under-reporting, as also observed in New Zealand [3] and England [5] and suggests that the available notification data are likely to also underestimate tetanus cases in the United States (Table 1). Notification for tetanus relies on clinicians, as laboratory confirmation of the disease is rare and unreliable and clinicians are known to under-notify more common infectious diseases [25]. There is evidence that under-notification also applies to more severe hospitalised cases [21]. In this analysis, hospitalisation data were examined and attempts made to account for multiple admissions and coding errors. Whilst the validity of this has not been tested by direct examination of hospital records, the high proportion of notifications that matched hospitalisations in our dataset provides some reassurance that misclassification is not substantial, as does the similar epidemiological pattern among notifications and hospitalisations.

The rate of tetanus cases was highest in non-metropolitan areas. This may in part be a result of behaviours or occupations (eg., farming) that increase exposure to tetanus reservoirs. Advancing age is probably of primary importance, however; as suggested by the absence of cases from the Northern Territory, a remote area of Australia which has a disproportionately young population.

In the present study, more cases, particularly in the elderly, occurred in females than males. This may be related to vaccination history, as many older men were vaccinated during military service [8].

Tetanus is a disease of older people and despite the progressive reduction in mortality rates in all age groups over the past 40 years, rates in those aged over 70 years remain higher than in any other age group. The steep increase in the incidence of tetanus with advanced age has also been observed in New Zealand [3], the United States [1], England and Wales [5] and Italy [4]. Serosurveys conducted in Australia [8], the United States [11], Canada [12], England and Wales [10] and several European countries [6,7,9] have also found progressively lower prevalence of levels of tetanus antibody in older age groups. The Australian serosurvey showed lower seroprevalence in persons aged 40 years and over; 18% of persons aged 40–49 years had no immunity to tetanus, increasing to 37% in persons aged 60–69 years and to 53% in persons aged over 70 years [8]. Despite seroprevalence progressively decreasing in age groups from 40 years of age, the burden of tetanus morbidity is clearly skewed towards older groups, with 61% of the 98 tetanus hospitalisations in persons aged over 50 years occurring in persons aged 70 years and over. This is similar to the situation reported in England and Wales, where 59% of tetanus cases aged 65 years and over [5], despite gradually declining tetanus immunity in persons aged 40 years and over [10].

The Australian immunisation schedule recommends a booster of diphtheria–tetanus (dT) vaccine for adults at 50 years of age. However the low level of immunity in older Australians [8] suggests that this booster dose has limited uptake, as also noted in Switzerland and Canada [15,26]. The other major impetus for tetanus immunisation in adults is injury [15]; however, tetanus occurs in cases with trivial or no known injury and the definition of a ‘tetanus prone’ wound is unclear [5,27].

Various strategies have been considered to improve vaccine uptake in older adults. These include linking vaccination to other age-related medical tests [3] and opportunistic vaccination of elderly patients in hospitals [28]. However, linkage of immunisation to a specific age landmark is usually more effective and in Australia, North America and Europe, annual influenza immunisation is universally recommended in people aged 65 years and over [13,14,29], with high uptake [16–18]. The latter is probably linked to the supply of vaccine free of charge, as well as higher medical attendance for this age group. Tetanus vaccine for 50 year olds is not currently provided free of charge in Australia. Tetanus immunisation, if delivered at 50 years of age, unless coverage can be substantially improved, could only prevent 46% of hospitalisations and 45% of deaths, based on cases in persons over 50 years of age between 1993 and 2002. However, supply of funded vaccine routinely at 65 years of age with other funded vaccines is estimated to prevent an additional 9% (n = 9) of hospitalisations and 28% (n = 3) of deaths over the current approach of recommended vaccine at 50 years of age, assuming similar uptake to influenza vaccine. This is a conservative estimate of the impact of such a change, as it is based on a best case scenario for delivery of vaccine at 50 years and does not assume delivery of any booster vaccine prior to 65 years of age. Improved impact against tetanus from routine funded tetanus booster vaccination linked to routine influenza vaccination is also likely to be applicable to other comparable industrialised countries.

Acknowledgments

The National Centre for Immunisation Research and Surveillance of Vaccine Preventable Diseases is supported by the Australian Government Department of Health and Ageing, the New South Wales Department of Health and The Children’s Hospital at Westmead. Data from the National Notifiable Diseases Surveillance System were provided by the Australian Government Department of Health and Ageing. Data from the National Hospital Morbidity Database and the National Hospital Mortality Database were provided by the Australian Institute of Health and Welfare.

References


