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Estimating the risk of invasive group A *Streptococcus* infection in care home residents in England, 2009–2010

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SUMMARY

Invasive group A streptococcal (iGAS) infections cause severe disease and death, especially in residents of long-term care facilities (LTCFs). In order to inform iGAS prevention, we compared the risk of iGAS in LTCF residents and community residents. We identified LTCF residents among cases of iGAS from national surveillance (2009–2010) using postcode matching, and cases of hospital-acquired infections via hospital admission records. We used Poisson regression to calculate incidence rate ratios (IRR) and logistic regression to explore factors associated with case fatality rate (CFR). A total of 2741 laboratory-confirmed iGAS cases were matched to a hospital admission: 156 (6%) were defined as hospital-acquired. Out of the total cases, 96 (3·5%) were LTCF residents. Compared with community residents, LTCF residents over 75 years of age had a higher risk of iGAS infection (IRR = 1·7; 95% CI 1·3–2·1) and CFR (OR = 2·3; 95% CI 1·3–3·8). Amongst community-acquired cases, the risk of iGAS in LTCF residents between 75 and 84 years of age doubled (IRR = 2·7; 95% CI 1·8–3·9) compared with their community counterparts. The CFR among community-acquired cases was higher in LTCF residents than community residents (21% *vs.* 11%). Age remained associated with death in our final model. Our study showed that, even controlling for age, LTCF residents have a higher risk of acquiring and dying from iGAS. Whilst existing co-morbidities may explain this, it is reasonable to assume that the institutional setting may facilitate transmission. Therefore, cases in LTCF require prompt investigation together with a better understanding of factors contributing to the acquisition of infection.

Key words: Long-term care, aged, streptococcal infections, *Streptococcus pyogenes*.

INTRODUCTION

Residents of long-term care facilities (LTCFs) have a higher frequency of disabilities and co-morbidities than community residents, which puts them at an increased risk of acquiring infections [1]. Group A *Streptococcus* (GAS) can be carried asymptomatically in a small number of people (~1%), or may circulate in the community as impetigo, 'strep throat' or other non-invasive manifestations [2]. GAS most commonly causes pharyngitis and soft-tissue infections. However, it can also result in invasive disease, including bacteraemia, pneumonia, necrotising fasciitis and streptococcal toxic shock syndrome [3]. Disease onset and progression can be very rapid, and there is a high fatality rate, especially in the elderly and those with co-morbidities such as diabetes or cardiovascular disease [4–6]. Environmental factors such as the

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number of household inhabitants and residential overcrowding have been associated with invasive GAS (iGAS) infection [4, 7].

A study conducted in the USA in 2007 identified LTCF residents as a subset of elderly people at higher risk of iGAS infection [8]. Between 1998 and 2003, 23% of the iGAS cases identified over 65 years of age were residents of a LTCF. In 2000, the incidence of iGAS infection among LTCF residents was estimated to be almost six times higher than among age-matched community-based residents (41 *vs.* 7 per 100 000 persons, $P < 0{\cdot}01$) [8]. This is consistent with the finding of Jordan *et al.* [9] of a threefold to eightfold higher risk in LTCF residents over 65 years of age, with residents 1·5 times more likely to die of their infection.

In addition to the increased risk of developing iGAS infection in care home settings, the rate of secondary cases appears to be elevated in care home residents relative to those living in the community [10]. Outbreaks in these settings are likely to be under-recognised and under-reported [10, 11].

To inform the debate on the most appropriate public health management of the risk of iGAS infection to LTCF residents, we set out to achieve the following objectives: to describe the number and characteristics of iGAS cases in England; to estimate the overall crude incidence of iGAS during the study period by type of residence and age; to explore factors associated with death; and to compare the incidence of iGAS infection in LTCF residents and community residents by age group and place of acquisition (hospital- or community-acquired), using routine surveillance data for England from 2009 to 2010.

METHODS

Study population

Our study included all cases of GAS resident in England where the infection was cultured from normally sterile sites.

Study period

Cases with clinical specimens taken from January 2009 to December 2010 inclusive were included in the study.

Operational definitions

We defined a new episode of infection as cases with positive isolates more than 30 days apart. Based on incubation times, we considered cases of hospital-acquired infection those whose first GAS-positive specimen was collected $\geqslant 3$ days after admission to $\leqslant 3$ days after discharge from hospital. The remainder were considered community-acquired [12].

Data sources

Reporting of iGAS infection became statutory in 2010. However, laboratories in England were required to report such infections prior to the change in legislation, so the channels used for reporting remained the same. We obtained laboratory notifications of iGAS infection from the national laboratory reporting surveillance system (LabBase) [13], including information on patient demographics, residential postcode and specimen type.

Information on hospital admissions, including date of admission and outcome of admission (discharge, transfer, death), was derived from the Hospital Episode Statistics© (HES) system, a secure data warehouse managed by the Health and Social Care Information Centre (HSCIC) that contains details of all National Health Service (NHS) admissions in England [14].

A database of all LTCFs in the UK was derived from data supplied to Public Health England by HSCIC, based on registrations to the regulatory body for care homes in the UK [15]. This dataset is updated quarterly.

We used population denominators based on the Office for National Statistics (ONS) 2011 census data, including the number of people in England who live in communal establishments ('Local Authority care homes with or without nursing care' and 'other care homes with or without nursing care'). The LTCF resident population was derived by combining the numbers on those two categories [16].

Ascertainment of cases

We supplemented de-duplicated laboratory data with the HES dataset through record linkage using a unique patient identifier (NHS number). Residential postcodes from laboratory records were further linked to the list of LTCFs in England stored in ArcGIS© v10.2 (a geographic information system for creating maps and managing geographic data) to identify LTCF residents [17]. Dates of first positive specimen were compared with dates of hospitalisation in order to identify hospital-acquired cases.

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Table 1. *Characteristics of the cases of iGAS and cases over 75 years of age by type of residence in England, 2009–2010 (n = 2741)*

	LTCF ($n = 96$)		Community ($n = 2645$)		
Variables	No.	%	No.	%	*P*-value
Sex ($n = 2736$)[a]					
Female ($n = 1392$)	65	68	1327	50	0.001[b]
Male	31		1313		
Age group ($n = 2741$)					
Under 75 ($n = 1943$)	17	18	1926	73	>0.001[c]
75–84 ($n = 470$)	34	35	436	16	
85+ ($n = 328$)	45	47	283	11	
Place of acquisition of infection ($n = 2741$)					
community-acquired ($n = 2585$)	92	4	2493	96	0.352[b]
Hospital-acquired ($n = 156$)	4		152		
Characteristics of cases if iGAS aged $\geqslant 75$ years					
Age ($n = 798$)					
75–84	34	43	436	60	0.003[c]
$\geqslant 85$	45	57	283	40	
Sex ($n = 798$)					
Female	54	68	383	88	0.01[c]

[a] For five cases, the sex was not known.
[b] Fisher's exact test.
[c] χ^2 test.

Patient survival was assessed using outcome data included in the HES admission record.

Estimating the incidence and risk

We performed χ^2 or Fisher's exact test to evaluate the differences in the distribution of cases between community and LTCF residents. *t* Test or Wilcoxon's rank-sum test was used as appropriate to compare continuous variables. We used multivariable logistic regression to examine factors potentially associated with mortality. We controlled for age, sex, type of residence and season of the year in our model. We used Poisson regression analysis to estimate incidence rate ratios (IRR) comparing the rate of infection in LTCF residents and community residents and to explore potential interactions between type of residence and age group. All analyses were performed using STATA 13© [18].

RESULTS

We matched 2749 unique records of individuals with iGAS from the national laboratory surveillance system with specimen dates in 2009 and 2010 to hospital admission data. Eight cases were excluded on the basis of not having a residential postcode ($n = 7$, 0·2%) or date of admission ($n = 1$, 0·03%). We did not identify any cases with repeated infections (>30 days apart).

Characteristics of iGAS cases in England; 2009–2010

Of the 2741 cases included in the study, the majority had positive blood cultures (2466; 90%). The sex of the cases was evenly distributed, with 1392 (51%) being female (Table 1).

A total of 2585 (94%) cases were considered to have acquired their infection in the community, with the remaining 156 (6%) assigned as hospital-acquired. We identified 96 (3·5%) cases as being resident of a LTCF (Fig. 1), of which 92 (96%) acquired their infection in the care home and the remaining four (4%) in a hospital setting.

The overall CFR for iGAS cases was 12% (324/2471). Among LTCF residents, the CFR was 23% (22/96) compared with 11% (302/2645) in community residents (OR = 2·3; 95% CI 1·34–3·81; $P < 0·001$).

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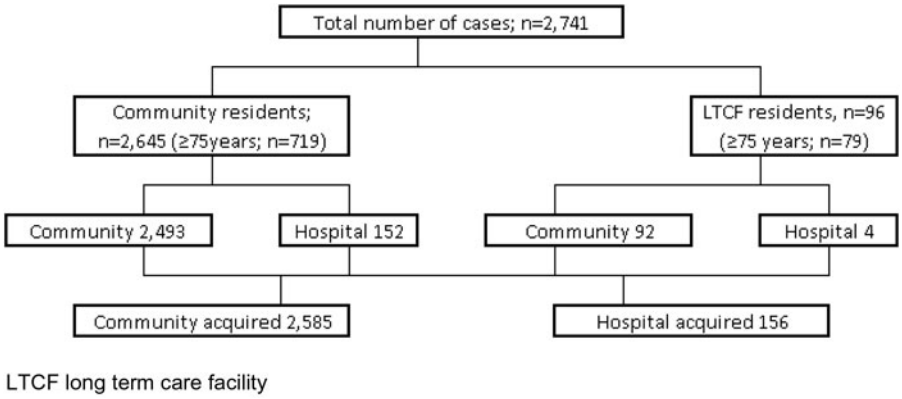

Fig. 1. Distribution of cases by type of residence and whether they are <75 years of age or 75 and above and likely place of acquisition of the infection, England 2009–2010.

Incidence of iGAS in England; 2009 to 2010

The crude incidence of iGAS infection in England for the period 2009–2010 was 2·5 cases per 100 000 population, with a higher risk among LTCF residents compared with community residents at 14·2 *vs.* 2·5/100 000 (IRR 5·7; 95% CI 4·6–7·0) (Table 2). In people over 75 years of age, the overall rate of infection was 9·7/100 000, with LTCF residents having nearly double the risk compared with community residents at 16·1 *vs.* 9·3/100 000 (IRR 1·7, 95% CI 1·3–2·1) (Table 2).

Analysis of community-acquired cases

A total of 2585 cases acquired their infection in the community. Of these, 92 (4%) were residents in a LTCF (Table 1). Out of the total, 709 (27%) were in people aged 75 years or older. Table 2 compares rates between LTCF and community residents for each age group and place of acquisition of infection. The incidence of iGAS was almost two times higher (15·2 *vs.* 8·2 per 100 000 population; IRR = 1·8; 95% CI 1·4–2·3) in LTCF residents over the age of 75 compared with residents in the community (Table 2). For cases between 75 to 84 years of age, the risk was more than double for LTCF residents compared with community residents (IRR = 2·7, 95% CI 1·8–3·9). The risk for cases over 85 years or older was similar across both groups (IRR = 1·1, 95% CI 0·8–1·5).

The CFR was 21% (19/92) in LTCF residents *vs.* 11% (256/2493) in community residents. Higher odds of dying were associated with living in a care home and being 75 years or older in the single variable analysis (Table 3). However, only age group remained significant when adjusted by sex, residence and season of the year (Table 3).

Analysis of hospital-acquired cases

A total of 156 cases acquired their infection in a hospital setting. Of these, four (2·5%) were residents in a LTCF (Table 2). Out of the total, 89 (58%) were aged 75 years or older. The incidence of iGAS in cases over 75 years of age was higher for community residents compared with LTCF residents (1·1 *vs.* 0·8/100 000) (Table 2). However, this finding was not significant. No hospital-acquired cases were identified in residents in LTCF younger than 75 years of age.

For hospital-acquired cases aged 75–84, there was a non-significant increased risk of iGAS infection in LTCF residents compared with community residents of the same age (IRR = 1·8, 95% CI 0·4–7·4) (Table 2). For cases over 85 years of age, the risk was lower in LTCF residents than in their community counterparts, although again not reaching statistical significance (IRR = 0·2, 95% CI 0·06–1·0) (Table 2).

The CFR for hospital-acquired cases was 31% (49/156). Three of the deaths were in LTCF residents and 46 in community residents.

DISCUSSION

Our study showed that LTCF residents are at an increased risk of developing iGAS infection compared with community residents. The crude incidence of iGAS in LTCF residents over 75 years of age was 16·1 per 100 000 population compared with 9·3 per 100 000 population in community residents. This result is lower than that reported in a similar study in the USA (41·0 *vs.* 6·9 per 10 000 population), although this study reported rates for cases aged over 65 years as a single group rather than stratifying further [8].

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Table 2. *Comparison of iGAS risk in LTCF residents and community residents by hospital- and community-acquired iGAS infection and age groups, England; 2009–2010 (n = 2741)*

	All cases		LTCF residents		Community residents			
	No.	Rate per 100 000	No.	Rate per 100 000	No.	Rate per 100 000	IRR	95% CI
All cases	2741	2.5	96	14.2	2645	2.5	5.7	4.6–7.0
Cases >75 years	798	9.7	79	16.1	719	9.3	1.7	1.3–2.1
Community-acquired cases								
All ages	2585	4.9	92	13.8	2493	2.3	5.8	4.7–7.1
75 years or older	709	17.3	75	15.2	634	8.2	1.8	1.4–2.3
Under 75 years	1876	1.9	17	9.6	1859	1.9	5.0	2.9–8.1
75–84 years	430	14.7	32	19.2	398	6.9	2.7	1.8–3.9
Over 85 years	279	23.6	43	13.2	236	11.9	1.1	0.8–1.5
Hospital-acquired cases								
All ages	156	0.3	4	0.6	152	0.14	4.1	1.5–11.2
75 years or older	89	2.2	4	0.8	85	1.1	0.7	0.2–2.0
Under 75 years	67	0.1	0	–	67	0.1	–	– to –
75–84 years	40	1.4	2	1.2	38	0.6	1.8	0.4–7.4
Over 85 years	49	4.2	2	0.6	47	2.3	0.2	0.1–1.0

IRR, incidence rate ratio; CI, confidence interval.

Table 3. *Factors associated with dying after iGAS infection in community-acquired cases, England; 2009–2010 (n = 2580[a])*

	Number deaths (%)	Total number	Crude OR (95% CI)	Adjusted OR (95% CI)
Sex				
Male	155 (47)	1344	Reference	
Female	169 (53)	1392	1.06 (0.83–1.35)	0.97 (0.76–1.23)
Age group (years)				
Under 75	151 (55)	1871	Reference	
75–84	65 (23)	430	2.02 (1.48–2.77)	2.01 (1.47–2.76)
>85	59 (22)	279	3.05 (2.19–4.25)	2.94 (2.08–4.16)
Residence				
Community	256 (93)	2488	Reference	
Care home	19 (7)	92	2.27 (1.27–3.87)	1.38 (0.79–2.39)
Season				
Winter	85 (31)		0.91 (0.63–1.32)	0.88 (0.61–1.29)
Autumn	72 (26)		0.74 (0.50–1.08)	0.71 (0.48–1.05)
Spring	52 (19)		Reference	
Summer	67 (25)		0.98 (0.67–1.45)	1.00 (0.68–1.49)

[a] Sex for five cases was not known; OR, odds ratio; CI, confidence interval.

Among community-acquired cases who were residents in a LTCF and between 75 and 84 years of age, the risk was almost three times higher than for a person of a similar age residing in the community (IRR = 2·7, 95% CI 1·8–3·9). The risk remained slightly elevated in LTCF residents over 85 years, but the difference was not significant. This might be a consequence of community and LTCF residents being more similar in terms of underlying co-morbidities or the small sample size. Similarly, the risk of hospital-acquired iGAS infection was also higher for LTCF residents between 75 and 84 years of age compared with their community counterparts, supporting the hypothesis that difference in co-morbidities or general levels of dependency may

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account for most of the increased risk in LTCF residents rather than the institutional nature of their residence. However, it is important to highlight that care homes are different environments to community settings and that direct comparisons should be made with caution.

Our estimate differs from that in a previous study in the USA [8] where LTCF residents over the age of 65 were estimated to be six times more likely to develop iGAS than community-based residents. Whilst the difference in the choice of age stratification (75 years as opposed to 65 years) may explain some of this difference, the US study did not consider hospital-acquired infections, which may have inflated their risk estimates in LTCF patients. Compared with community residents, LTCF residents are likely to have more disabilities and underlying medical conditions that might increase their need for hospital admission and their risk of acquiring infectious diseases in that setting [1, 6, 19, 20].

The reported risk of acquiring iGAS from a close household contact varies in the literature from around 229 to >2000 [4, 6, 21]. The nature of the vulnerable population and the close contact between staff and patients may increase the risk of secondary transmission in that setting. Outbreaks of iGAS infection in care homes have been frequently reported in the literature [10, 22, 23]. Breaches in infection control standards together with environmental contamination were found to be factors likely to increase transmission within these settings [10]. This, together with the probable presence of co-morbidities in this population group, is likely to contribute to the increase in risk observed [4, 6]. A study in Canada identified previously unrecognised outbreaks in four out of seven LTCFs after the investigation of one case of iGAS [6]. Thus, cases in a LTCF may demand rapid investigation and prospective and retrospective surveillance to detect further cases.

Regardless of possible explanations for the increased risk of iGAS in LTCF settings, and in recognition of this increased susceptibility of LTCF residents, the guidelines for prevention and control of group A streptococcal infection in acute healthcare and maternity settings in the UK describe best practice for the management of single and multiple cases in LTCFs [24].

Limitations

Since we matched cases to LTCFs using postcodes, there is a possibility that some community cases might have been erroneously allocated to a LTCF if they lived in a residence sharing a postcode with a care home. In the 2011 census in England and Wales, each postcode is estimated to be shared by a median of 14 occupied households (range 0–646), thus we consider that this is unlikely to be a major source of bias [25].

We used population data from the 2011 census for our denominators. This dataset contains estimates on LTCF residents by age group. Even though our study period includes 2009 and 2010, we could not find any evidence to suggest considerable differences in age and LTCF residency in 2011 compared with the years included in the study period.

Other reports have shown differences in co-morbidities between LTCF and community residents. We did not have information in our dataset about these possible confounders, and thus our calculated increased risks of LTCF residency does not include any intrinsic effect of care home residence and frailty or underlying illness.

It is known that iGAS incidence fluctuates year on year. We obtained data from 2009, a high-incidence year [26]. However, we have no reason to believe that a higher incidence of iGAS would also impact on the specific distribution of cases in LTCFs and community residents, although this cannot be entirely ruled out.

Conclusion

Our study showed that people living in LTCF are at an increased risk of acquiring and dying of iGAS infection. This is likely to be due to the greater presence in this group of underlying medical conditions and non-intact skin through which infection may pass. Exposure to healthcare interventions may also aid further transmission. In view of this, single cases of iGAS infection in LTCF residents should be followed by a prompt risk assessment. Further understanding of specific risk factors within this group could assist in the prevention and management of GAS transmission in this setting.

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DECLARATION OF INTEREST

The authors declared no conflicts of interest.

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