Capturing the chance for pneumococcal vaccination in the hospital setting

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Abstract
Introduction. Because of the relevant burden of pneumococcal diseases, newborns, people at risk and elderly are recommended vaccination but coverage is still low for problems in catching them. This study evaluates the proportion of eligible patients seen at hospital level in the view of assessing its potential role in vaccination campaigns.

Methods. This is a retrospective analysis of discharge data of all patients over 49 years of age admitted between 2011 and 2013 to “A. Gemelli” teaching hospital. Eligibility for pneumococcal vaccination was evaluated based on ICD-9 codes.

Results. Among 65,047 unique patients, 53.2% were eligible for pneumococcal vaccination. Most common eligibility criteria were chronic heart diseases, cancer and diabetes. Considering also age ≥ 65 as an indication to vaccination, the proportion of eligible patients reached 76.8%. The highest number of eligible patients was seen in medical sciences, general surgery, cardiovascular medicine and neurosciences departments.

Conclusions. Hospital might play an important role in catching patients eligible for pneumococcal vaccination because their proportion in the hospital setting is high.

INTRODUCTION

Streptococcus pneumoniae (Sp) is responsible for different diseases: upper and lower respiratory infections – i.e. community-acquired pneumonia (CAP) – particularly in elderly, as well as otitis and invasive pneumococcal diseases (IPD), e.g. meningitis and bacteremia, especially in children. Sp is a leading cause of infection worldwide and in all age groups with elderly and people with one or more risk factors showing the highest incidence rates and burden of disease [1]. Chronic medical conditions, such as chronic liver disease, chronic heart or lung disease, diabetes, asthma, neuromuscular disorders as well as alcohol abuse, smoking, asplenia and immunocompromising conditions are the main risk factors for Sp [2,3]. Furthermore, accumulation of concurrent at-risk conditions significantly increases the risk, independently of age [4-6]. Alongside an increased incidence of pneumococcal diseases, patients at risk occur also higher costs if affected [7].

Sp is responsible of around 30% of all CAP [8,9]. Annual incidence rates of CAP are estimated to range from 1.6 to 11.6 per 1000 [10,11]. Nevertheless, the incidence rate is four-times higher in elderly and at risk people as compared to younger people [7,12,13]. Furthermore, elderly and patients at risk for Sp have also a higher mortality [14].

According to the data from the European Centre for Disease Prevention and Control, the incidence of IPD varies from 0.2 to 13.4 cases per 100,000 population across EU/EEA countries [15] with a lethality of 3-35% [16,17]. Italy has reported an incidence rate of confirmed cases of 2.41 per 100,000 in 2016. Nevertheless, looking only at Regions that pay more attention to notification, the incidence increases to 4.58 per 100,000 [18].

Three vaccines are available in order to protect against pneumococcal diseases, namely the 13-valent and the 10-valent pneumococcal conjugate vaccine (PCV10 and PCV13) and the 23-valent polysaccharide (PPV23). They are directed towards different Sp serotypes allowing protection against a part of pneumococcal diseases. Currently the PCV13 is included in the National Immunization Program (NIP) of some European countries for vaccination of newborns. The vaccine has been also licensed for the use in all age groups for the prevention of CAP and IPD. PCV13 provides elderly and patients at risk with a new weapon against pneumococcal diseases. In fact, the other vaccine used in this target population, i.e. the PPV23, has shown some limits [19].

PCV13 has been shown to reduce vaccine-type CAP by 45% and vaccine-type IPD by 75% [20]. Consequently, the current Italian NIP recommends vaccinating elderly and people at risk [3].

Although the herd effect of the infant vaccination programme is meant to indirectly protect unvaccinated infants.
people, the burden of preventable pneumococcal diseases remains high, in particular in elderly and people at risk [21]. Eventually, vaccinating all groups at risk for Sp would have a relevant public health impact [22]. In Italy, both the previous (2012-2014) and the current (2017-2019) NIP recommends vaccination in newborns but also in people at risk for Sp, including elderly [3, 23]; the last one recommends a sequential administration of PCV13 and PPV23 at 65 years. Following the approval of the 2012-2014 NIP, each Region has delivered its own Immunization Program enclosing details on patients at risk for Sp and on vaccination strategies to catch them. Lazio Region, at the end of 2012, delivered the list of conditions at risk for Sp [24]. Nevertheless, from 2012 onward, no specific vaccination campaigns were implemented to reach people at risk. Only at the end of 2015, the Region has set an age based vaccination campaign targeting elderly, which was not uniformly implemented. Vaccination coverage among elderly is very low with regional estimates ranging from 0.7% to 50% [25]. Even though data for people at risk are not known, it may be expected that vaccination coverage is low also among them. In fact, also international evidence shows that, albeit the most of patients with pneumococcal diseases have two or more risk factors, vaccination coverage in population at risk for Sp is quite low, 25-30% overall [26-27].

In the light of this context, the Università Cattolica del Sacro Cuore has performed a pilot project together with the Fondazione Policlinico Universitario “A. Gemelli” aimed at identifying and vaccinating patients at risk for Sp in the hospital setting. Within the project, a retrospective assessment of the amount of people likely eligible to receive pneumococcal vaccination was carried out to characterize their distribution across hospital wards and departments. This analysis, together with the results of the prospective phase of the project on vaccination of people at risk in the hospital, which will be the objective of a further paper, could be helpful in order to inform decision makers about the more suitable setting and ways to offer people at risk for Sp with the vaccination.

MATERIALS AND METHODS

A retrospective analysis was performed to identify patients eligible to receive pneumococcal vaccination among all people aged 50 years or older admitted in a three-year period between January 1st 2011 and December 31st 2013 to any of the departments of the Fondazione Policlinico Universitario “A. Gemelli”. The hospital is located in Lazio, a Region housing, in the three-year study period, a mean of 5,520,061 people (9.3% of the Italian population) [28]. According to 2013 mission report, the Fondazione Policlinico Universitario “A. Gemelli”, in the three-year study period, had a total of 120,010 hospital admissions were recorded at the Fondazione Policlinico Universitario “A. Gemelli”. These admissions corresponded to 65,046 unique patients (54.2% of the admissions in the study period were first admissions). Females were 33,497 (51.5% of the sample); median age was 68 (interquartile range: 17), and 38,879 (59.8%) patients were aged 65 or above. Of the 65,046 unique patients, 46,785 (71.9%) underwent an ordinary admission, 18,076 (27.8%) a day hospital or a day surgery and 185 (0.3%) were admitted to rehabilitation units. Between January 1st 2011 and December 31st 2013, a total of 120,010 hospital admissions were recorded at the Fondazione Policlinico Universitario “A. Gemelli”. These admissions corresponded to 65,046 unique patients (54.2% of the admissions in the study period were first admissions). Females were 33,497 (51.5% of the sample); median age was 68 (interquartile range: 17), and 38,879 (59.8%) patients were aged 65 or above. Of the 65,046 unique patients, 46,785 (71.9%) underwent an ordinary admission, 18,076 (27.8%) a day hospital or a day surgery and 185 (0.3%) were admitted to rehabilitation units. For each patient, only the first admission to the hospital in the study period was considered, while the following admissions were excluded from the analysis. Demographic data (gender, date of birth, place of residence) were used to identify and subsequently exclude following admissions. Eligibility criteria were defined according to vaccination recommendations proposed by the Lazio Region for pneumococcal vaccination [24]. These recommendations overlap with national ones included in the previous and in the current NIP. The following conditions were considered increasing the risk for pneumococcal disease: chronic heart, lung or liver diseases; alcoholism; diabetes mellitus; cerebrospinal fluid fistulas; sickle cell disease and thalassemia; congenital or acquired immunodeficiency; anatomic or functional asplenia; leukemia, lymphoma or multiple myeloma; disseminated cancers; organ or bone marrow transplant; clinically significant iatrogenic immunosuppression; chronic renal failure, nephrotic syndrome; HIV; presence of a cochlear implant. Eligibility criteria for pneumococcal vaccination were identified using the ICD-9-CM codes that were in force during the study period in Italy [30]. For each patient, data reported in both primary and secondary diagnoses and in procedures fields were taken into account. Eligible patients were defined as those who showed at least one of the aforementioned criteria in any of the fields described. Since the WHO and the current 2017-2019 NIP recommend vaccinating against pneumococcal disease all subjects aged 65 or older [3, 31], we also stratified the results for age class focusing the attention to the age group 50-64. Furthermore, a secondary analysis was performed considering eligible both people with one of the abovementioned criteria and those ≥ 65 years of age. In order to assess the potential role of the hospital as a setting for catching people at risk for Sp, the overall proportion of patients eligible for pneumococcal vaccination was calculated. The analysis was also stratified by type of hospitalization (ordinary, day hospital or day surgery, rehabilitation), department and unit of admission. The distribution of patients eligible for pneumococcal vaccination by eligibility criteria was also analyzed. The statistical analysis was performed using the IBM SPSS 22.0 software for Windows.

RESULTS

Between January 1st 2011 and December 31st 2013, a total of 120,010 hospital admissions were recorded at the Fondazione Policlinico Universitario “A. Gemelli”. These admissions corresponded to 65,046 unique patients (54.2% of the admissions in the study period were first admissions). Females were 33,497 (51.5% of the sample); median age was 68 (interquartile range: 17), and 38,879 (59.8%) patients were aged 65 or above. Of the 65,046 unique patients, 46,785 (71.9%) underwent an ordinary admission, 18,076 (27.8%) a day hospital or a day surgery and 185 (0.3%) were admitted to rehabilitation units. Overall, 34,575 unique patients were eligible for pneumococcal vaccination (53.2% of the sample), with 10,970 patients showing more than one criteria (16.9% of the sample, 31.7% of the eligible subjects). Most commonly observed eligibility criteria were chronic heart dis-
cases (28.3% of the admitted patients), cancer (21.3%), diabetes (8.5%) and chronic lung disease (5.0%) (Table 1). When considering also the age (≥ 65 years of age or above) as a criterion for vaccination, the proportion of eligible patients raised to 76.8%. In particular, 15,380 patients (23.6% of the whole sample) showed no other vaccination criteria than age.

Table 2 reports the figures of patients eligible for pneumococcal vaccination because either ≥ 65 years of age or affected by an at-risk condition in each department and single unit.

Of the 38,879 patients aged 65 or above, 23,499 (60.4%) showed at least one risk condition for Sp as compared to 11,076 out of 26,167 among patients under the age of 65 (42.3%) (Table 3).

Of the 46,785 patients who were seen during an ordinary admission, 27,612 were eligible for vaccination (59.0%) while of the 18,076 patients seen during a day hospital/surgery admission 6,858 (37.9%) were eligible. One-hundred sixteen out of 185 patients admitted to any of the rehabilitation units (62.7%) were also eligible.

In terms of relative frequencies, the departments showing the highest proportion of eligible patients were as follows: radiology (which includes the radiotherapy unit and in which 94.8% of the patients were eligible for pneumococcal vaccination), cardiovascular medicine (85.4%) and the public health department (which includes the infectious diseases units, 77.4%). In terms of absolute numbers, most of the eligible patients were observed in the medical sciences department (8,485 patients), the general surgery department (6,852), the department of cardiovascular medicine (5,502) and the department of neurosciences, gerontology and orthopedic surgery (4,564).

Table 1
Distribution of patients eligible for pneumococcal vaccination according to the Lazio Region recommendations [24]. For each condition, the corresponding ICD-9-CM codes used to assess the prevalence are reported

<table>
<thead>
<tr>
<th>Criteria</th>
<th>ICD-9-CM codes</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chronic heart disease</td>
<td>394.0-398.99; 401.0-402.91; 412; 413.0-414.9; 416.0-416.9; 423.1-426.89; 427.31-427.32; 428.0-428.9; 429.0-429.9; 440.0-440.9</td>
<td>18,400</td>
<td>28.3</td>
</tr>
<tr>
<td>Disseminated cancers</td>
<td>140.0-195.8; 196.0-198.8; 199.0; 199.1</td>
<td>13,861</td>
<td>21.3</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>250.00-250.93</td>
<td>5,561</td>
<td>8.5</td>
</tr>
<tr>
<td>Chronic lung disease</td>
<td>114.4; 400-496; 500-505; 506.4; 506.9; 508.1; 514-516.9; 517.1-517.8; 518.1-518.3; 518.83-518.84</td>
<td>3,258</td>
<td>5.0</td>
</tr>
<tr>
<td>Clinically significant iatrogenic immunosuppression</td>
<td>V58.1-V58.12; V58.65; E933.1</td>
<td>2,191</td>
<td>3.4</td>
</tr>
<tr>
<td>Chronic liver disease</td>
<td>070.22-070.23; 070.32-070.33; 070.44; 070.54; 571.5; 571.8-571.9</td>
<td>1,557</td>
<td>2.4</td>
</tr>
<tr>
<td>Chronic renal failure or nephrotic syndrome</td>
<td>585.1-585.9; 403.00-403.91; 404.00-404.93; 405.01; 581.0-581.9; V13.03</td>
<td>1,341</td>
<td>2.1</td>
</tr>
<tr>
<td>Leukemia, lymphoma, multiple myeloma</td>
<td>200.0-208.91</td>
<td>1,242</td>
<td>1.9</td>
</tr>
<tr>
<td>HIV</td>
<td>042; V08</td>
<td>1,782</td>
<td>0.3</td>
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<tr>
<td>Alcoholism</td>
<td>291.0-291.9; 292.2; 303.90-303.93; 305.00-305.03; 357.5; 425.5; 535.3; 571.0; 980.0; V11.3; V79.1</td>
<td>1,757</td>
<td>0.3</td>
</tr>
<tr>
<td>Anatomic or functional asplenia</td>
<td>41.5; 759.0</td>
<td>76</td>
<td>0.1</td>
</tr>
<tr>
<td>Organ or bone marrow transplant</td>
<td>33.30-33.52; 33.6; 37.51; 41.00-41.09; 41.94; 46.97; 50.51; 50.59; 52.80-52.86; 55.61; 55.69</td>
<td>61</td>
<td>0.1</td>
</tr>
<tr>
<td>Presence of a cochlear implant</td>
<td>20.06-20.99; 95.49</td>
<td>54</td>
<td>0.1</td>
</tr>
<tr>
<td>Congenital or acquired immunodeficiency</td>
<td>270.0-270.93; 279.8-279.9</td>
<td>33</td>
<td>0.1</td>
</tr>
<tr>
<td>Sickle cell disease or thalassemia</td>
<td>282.41-282.49; 282.60-282.69</td>
<td>20</td>
<td>&lt; 0.1</td>
</tr>
<tr>
<td>Cerebrospinal fluid fistulas</td>
<td>02.12; 388.61</td>
<td>4</td>
<td>&lt; 0.1</td>
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</table>

DISCUSSION
According to our retrospective study, the hospital seems a promising setting in order to catch and to vaccinate those at risk for pneumococcal diseases, as 53.2% of the patients aged 50 years or older are eligible for vaccination because of the presence of a chronic condition or immunodepression. Eligible patients were more frequently observed in the cardiovascular medicine department (5,502 subjects overall, corresponding to 85.4% of the patients admitted to that department), the internal medicine units (3,659, 81.0%) and the geriatric ward (1,043, 82.1%). All these accounted for 29.5% of eligible patients observed in the over 100 wards, rehabilitations and day hospital/day surgery units of the hospital. Therefore, these departments/units could be best suited for identifying patients eligible to receive pneumococcal vaccination. Even if radiotherapy ward
### Table 2
Distribution of patients eligible for pneumococcal vaccination stratified by hospital department and unit

<table>
<thead>
<tr>
<th>Department</th>
<th>Unit</th>
<th>N total admission</th>
<th>N eligible</th>
<th>Eligible (%)</th>
<th>N eligible</th>
<th>Eligible (%)</th>
</tr>
</thead>
<tbody>
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<td><strong>Department of medical sciences</strong></td>
<td>Internal and clinical medicine*</td>
<td>1923</td>
<td>1516</td>
<td>78.8</td>
<td>1819</td>
<td>94.6</td>
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<td></td>
<td>Internal medicine (and angiology)*</td>
<td>1501</td>
<td>1284</td>
<td>85.5</td>
<td>1439</td>
<td>95.9</td>
</tr>
<tr>
<td></td>
<td>Internal medicine (and gastroenterology)*</td>
<td>1090</td>
<td>859</td>
<td>78.8</td>
<td>994</td>
<td>91.2</td>
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<td></td>
<td>Endocrinology</td>
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<td>768</td>
<td>72.7</td>
<td>935</td>
<td>88.5</td>
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<td></td>
<td>Pulmonology</td>
<td>524</td>
<td>485</td>
<td>92.6</td>
<td>513</td>
<td>97.9</td>
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<tr>
<td></td>
<td>Dermatology</td>
<td>296</td>
<td>190</td>
<td>64.2</td>
<td>230</td>
<td>77.7</td>
</tr>
<tr>
<td></td>
<td>Obesity diseases</td>
<td>339</td>
<td>265</td>
<td>78.2</td>
<td>315</td>
<td>92.9</td>
</tr>
<tr>
<td></td>
<td>Hematology</td>
<td>374</td>
<td>318</td>
<td>85.0</td>
<td>341</td>
<td>91.2</td>
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<td>Oncology</td>
<td>664</td>
<td>648</td>
<td>97.6</td>
<td>653</td>
<td>98.3</td>
</tr>
<tr>
<td></td>
<td>Day hospital**</td>
<td>4109</td>
<td>2152</td>
<td>52.4</td>
<td>2836</td>
<td>69.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>11 877</td>
<td>8485</td>
<td>71.4</td>
<td>10 075</td>
<td>84.8</td>
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<td><strong>Department of cardiovascular medicine</strong></td>
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<td>2944</td>
<td>2655</td>
<td>90.2</td>
<td>2813</td>
<td>95.6</td>
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<td></td>
<td>Cardiac and vascular surgery*</td>
<td>1981</td>
<td>1814</td>
<td>91.6</td>
<td>1919</td>
<td>96.9</td>
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<td>Coronary unit</td>
<td>896</td>
<td>593</td>
<td>66.2</td>
<td>755</td>
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<td>145</td>
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<tr>
<td><strong>Total</strong></td>
<td></td>
<td>6442</td>
<td>5502</td>
<td>85.4</td>
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<td>646</td>
<td>37</td>
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<td>Gynecologic oncology</td>
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<td>252</td>
<td>74</td>
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<td>133</td>
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<td></td>
<td>Breast surgery</td>
<td>854</td>
<td>765</td>
<td>89.6</td>
<td>801</td>
<td>93.8</td>
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<tr>
<td></td>
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<td>405</td>
<td>66.9</td>
<td>441</td>
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<tr>
<td><strong>Total</strong></td>
<td></td>
<td>3977</td>
<td>2568</td>
<td>64.6</td>
<td>3003</td>
<td>75.5</td>
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<td>44.8</td>
<td>1247</td>
<td>74.8</td>
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<td></td>
<td>Rehabilitation***</td>
<td>185</td>
<td>116</td>
<td>62.7</td>
<td>176</td>
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<td>1043</td>
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<td></td>
<td>Stroke unit</td>
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<td>322</td>
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<td>2795</td>
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<td><strong>Total</strong></td>
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<td>712</td>
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<td>General surgery (and transplants)*</td>
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<td>647</td>
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<td>General surgery (and hepatobiliary surgery)*</td>
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<td>733</td>
<td>77.6</td>
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<td>General surgery (and endocrine surgery)*</td>
<td>1693</td>
<td>342</td>
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<td>846</td>
<td>50.0</td>
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<td>Urology</td>
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<td>Plastic surgery</td>
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<td><strong>Total</strong></td>
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<td>6852</td>
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<td><strong>Department of diseases of the head and neck</strong></td>
<td>Neurosurgery*</td>
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### Table 2
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*At least two units combined. **At least two day hospital units combined. ***Includes four units exclusively dedicated to rehabilitation admissions.

### Table 3
Distribution of patients eligible for pneumococcal vaccination because affected by at least one at risk condition, stratified by hospital department and unit and age

<table>
<thead>
<tr>
<th>Department</th>
<th>Unit</th>
<th>50-64 years of age</th>
<th>65+ years of age</th>
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<tbody>
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<td></td>
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<td>N eligible</td>
<td>Eligible (%)</td>
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<td>75.2</td>
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<td>247</td>
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</tr>
<tr>
<td></td>
<td>Internal medicine (and gastroenterology)*</td>
<td>241</td>
<td>71.5</td>
</tr>
<tr>
<td></td>
<td>Endocrinology</td>
<td>240</td>
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<td></td>
<td>Pulmonology</td>
<td>94</td>
<td>89.5</td>
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<tr>
<td></td>
<td>Dermatology</td>
<td>72</td>
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</table>
and day hospital and the oncology units only registered, respectively, 705 and 648 cases of patients eligible for pneumococcal vaccination, these represented nearly all their patients (94.8% and 97.6% respectively). Consequently, also such units could play a role in catching patients at risk.

When considering also all patients aged 65 or older eligible for vaccination even though without risk factors for pneumococcal diseases, the proportion of eligible patients considerably increased to around 77%. An age-based vaccination campaign would probably catch elderly people outside the hospital setting. However, it should be taken into consideration that, in our study, more than 40% of subjects younger than 65 years of age showed at least one of the eligibility criteria for pneumococcal vaccination. These subjects could be reached by their general practitioners but, because of the supposed low level of vaccination coverage, we may suggest that this target could also benefit from a hospital based campaign. In fact, the check of vaccination status and the inclusion of vaccination in inpatient pathways have already been investigated as a solution to increase coverage against influenza and Sp [32-34]. The high proportion of subjects at risk among people < 65 years of age confirms that the hospital may work as a valuable setting for increasing vaccination coverage. These patients were more commonly seen in different settings as compared to the whole group of eligible subjects. In fact, they were also frequently observed, in absolute terms, in the department of obstetrics and gynecology and in the day hospital of the medical sciences department. This is probably due to the high prevalence of

Table 3
Continued

<table>
<thead>
<tr>
<th>Department</th>
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<th>65+ years of age</th>
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*At least two units combined. **At least two day hospital units combined. ***Includes four units exclusively dedicated to rehabilitation admissions.
REFERENCES

1. Torres A, Blasi F, Peetermans WE, Viegi G, Welte T. The living with other cancers or diabetes. breast or cervical cancer and of relatively young people living with other cancers or diabetes.


coccus pneumoniae in community-acquired pneumonia among adults in Europe: a meta-analysis. Eur J Clin Mi-


