Abstract

Background: Enterobacteriaceae have become one of the most important causes of infections for humans. Beta-lactams and fluoroquinolones are used to treat infections caused by these bacteria. However, resistance to these antibiotics has increased in Europe in the past years. Extended spectrum β-lactamase (ESBL) producing organisms, produce bacterial enzymes that inactivate the vast majority of β-lactam antibiotics by hydrolysis. Refugees, coming to Europe, may contribute to the import of antibiotic-resistant bacteria to Europe.

Methods: For the purpose of this review, articles on carriage rates of the multidrug resistant bacteria, specified to Extended Spectrum Beta-Lactamase producing Enterobacteriaceae (ESBL-E), among refugees coming to Europe were used. An English-language Pubmed and Google Scholar search were conducted to identify literature on the prevalence of ESBL-E in refugees, resident people and travelers.

Results: Using the above described methodology, 10 relevant articles regarding refugees and some more articles regarding resident people and travelers were identified. The articles were summarized.

Discussion: This review gives a complete overview on the prevalence of ESBL-E in refugees coming to Europe.

Conclusion: It's still unclear to what extent refugees carry and import ESBL-E into Europe.

The contribution of refugees to ESBL-E import in Europe

Jessie Gommers

Introduction

Antibiotics are chemical substances secreted by micro-organisms to kill other competing micro-organisms or to inhibit the growth of these micro-organisms. Antibiotics are of great importance in the prevention and treatment of infections in humans and animals, since they can inhibit the growth of bacteria and, in case of bactericidal antibiotics, can kill the infectious microbe themselves (1). Beginning around the middle of the 20th century, major advances in antibacterial drug development helped to solve many infections in humans and animals.

However, the euphoria over the antibacterial drug development was short lived (2). Resistance has always existed, but shortly after the beginning of the use of antibiotics, the spread of bacteria that develop mechanisms to combat against antibiotics for their own survival increased (3). They responded by producing various forms of resistance. Due to resistant bacteria,
the treatment of bacterial infections is increasingly complicated (2).

Enterobacteriaceae have become one of the most important causes of infections for humans. Beta-lactams and fluoroquinolones are used to treat infections caused by these bacteria. However, resistance to these antibiotics increased in Europe in the past years (4). Extended spectrum β-lactamase (ESBL) producing organisms produce bacterial enzymes that inactivate the vast majority of β-lactam antibiotics by hydrolysis (5). ESBLs are typically encoded on large, plasmids that can be exchanged between bacterial species. Most often they are on integrons, which are genetic structures that express and are capable of acquiring and exchanging gene cassettes. These plasmids often carry other resistance genes as well. Therefore, it is common for organisms expressing an ESBL to express co-resistances to other antibiotics like: aminoglycosides, trimethoprim-sulfamethoxazole, and tetracyclines. This means that ESBL-producing bacteria are multidrug resistant, which poses a particular challenge for the treatment of infections (6).

Foreign travel has been suggested to be a risk factor for the acquisition of ESBL-producing Enterobacteriaceae, especially foreign travel to countries which have higher prevalence of ESBL-producing Enterobacteriaceae. For many antibiotic-resistant bacteria the problem is more pronounced in developing countries, where various factors select for antimicrobial resistance genes and encourage their dissemination. Factors like migration, overcrowding, over the counter sale of antibiotics and bad hygiene encourage the exchange of antibiotic-resistant bacteria, thereby increasing the prevalence of antibiotic-resistant bacteria and the probability of their spread (7). These are mainly countries outside Europe, such as India (8). The prevalence of ESBL-producing Enterobacteriacea is clearly increasing, and in many parts of the world 10–40% of strains of Escherichia coli and Klebsiella pneumoniae express ESBLs (9). This increase in multidrug-resistance is associated with increased morbidity and mortality, higher costs in health care and with the need to use broader spectrum antibiotics to treat common infections (10).

The widespread overuse and misuse of antibiotics facilitates the development of antibiotic-resistant bacteria (11). The risk of transmission of antibiotic-resistant bacteria from one country to another increases, since more people are traveling around the world. Therefore the emergence of an antibiotic-resistant bacterium in one location becomes a global problem. Since more people are crossing the borders, there is a greater opportunity for antimicrobial-resistant bacteria to be spread across countries. The potential routes of importation of antimicrobial-resistant bacteria are through short- and long-term travelers but also from immigrants and refugees (7).

There is a high influx of refugees to the European Union. Many refugees are coming from countries with a high prevalence of antibiotic-resistant bacteria, such as Afghanistan, the Near and Middle East and the North African countries (12). Therefore, refugees coming to Europe may contribute to the import of antibiotic-resistant bacteria to Europe.

This article will focus on the carriage rates of the multidrug resistant bacteria, specified to Extended Spectrum Beta-Lactamase producing Enterobacteriacea (ESBL-E), among refugees. In this article the focus will be on refugees from all over the world coming to Europe. It is important to know to what extent refugees carry and import ESBL-E, in order to adapt infection prevention and control policies as well as empirical antibiotic treatment guidelines.

Method

This narrative review is based on material derived from a literature search conducted using two computerized databases; Google Scholar and PubMed. To identify articles possibly missed by the search, manual searches in reference lists of primary articles were also conducted in order to attempt to identify all relevant articles on the prevalence of ESBL-E in refugees coming to Europe. The topic search terms used for searching the databases were ‘ESBL’, ‘Extended spectrum beta-lactamases’, ‘E.coli’, ‘Klebsiella’, ‘K. pneumoniae’, ‘refugees’ and ‘travelers’.

For inclusion the article needed to fulfil the following criteria [1]: reporting on screening in refugees coming to Europe [2], presenting the prevalence of ESBL-E in refugees, [3] published in English and [4] published between the years 2000 and 2017. Articles which did not meet these criteria were excluded.

Before including an article screening of the abstracts was performed. If the abstracts met the inclusion criteria, the full texts of the articles were read.
and the articles were selected or rejected for inclusion in the narrative review. In total 10 articles on the prevalence of ESBL-E in refugees coming to Europe were included. All articles were based on cross-sectional studies. The following data were extracted from each article: study design, year of publication, country of study, the method for screening refugees, the results on ESBL-E prevalence and the conclusion. To make a clear overview of the prevalence of ESBL-E in refugees coming to Europe a table, including all 10 articles, was made. Besides the articles on the prevalence of ESBL-E in refugees, articles on the prevalence of resident people and travelers were used as well to compare ESBL-E colonization.

Additionally, limitations of the included studies are discussed and recommendations to improve the studies are made, in order to learn more about the contribution of refugees to the import of ESBL-E to Europe.

Results

Using the above methodology, 10 relevant articles regarding the carriage of ESBL-producing Enterobacteriaceae in refugees were identified.

Colonization of ESBL-E in refugees

In order to know to what extent refugees carry and import ESBL-E to Europe it is helpful to look at the prevalence of the colonization of ESBL-E in refugees. The ten studies included in this paper, all investigated the prevalence of ESBL-E in refugees. The detailed results of these studies are shown in table 1. Table 1 shows quite variable carriage rates of ESBL-E among refugees between the different studies. Overall the average percentage is around 30%. The differences in ESBL-E colonization rates can be due to multiple reasons.

**E. coli and K. pneumoniae**

With exception of two studies among only Syrian refugees, all other studies show a colonization rate of ESBL-E between 7.3% and 35%. ESBL’s are found in Enterobacteriaceae, a group of (gram-negative) bacteria belonging to the normal human and animal intestinal flora. *Escherichia coli* and *Klebsiella pneumoniae* are the most common ones. All ten studies mention *Escherichia coli*, also known as *E. coli*. Five of the ten studies (12-16) subdivide ESBL-E in *E. coli* and *K. pneumoniae*. Four of these studies (12-15) indicated *E. coli* is more common than *K. pneumoniae*. One of those studies is done by Tenenbaum and colleagues (15), they screened refugee children on colonization of ESBL-E via rectal swab in a German university children hospital. In Germany, recommendations for multidrug resistance organisms screening of pediatric refugees were recently published. According to these and institutional recommendations, all hospitalized pediatric refugees were screened for multidrug resistant organisms between October 2015 and March 2016. Among the 325 patients hospitalized 26.8% (87/325) were colonized with ESBL-E, of which 68 patients were colonized with *E. coli* and 18 patients with *K. pneumoniae*.

High colonization of ESBL-E in Syrian refugees

One remarkable fact is that the two highest percentages of colonization with ESBL-E are in studies done with refugees from only Syria. Kassem et al. (17) conducted the study among 107 children between the age of 0 and 17 years who were ill or wounded from the civil war and had been secretly transported across the border for treatment in Israel. The Syrian children were screened for multidrug resistance using culture sites from nares, axilla, groin, rectum, and open wounds. 77.8% (83 of 107) of those Syrian children were colonized with ESBL-E, whereas 15.0% (16/107) of them suffered from an infection caused by ESBL-producing bacteria. Another study done by Peretz and colleagues (18) also focused on the colonization of ESBL-E in Syrian children. In their study 29 Syrian children were screened for multidrug resistance at Galilee Medical Center in Israel. Among those children 65.5% (19/29) were colonized with ESBL-E. Although the percentages of colonization with ESBL-E in these latter studies are quite high, the percentage of colonization of ESBL-E in Syrian adult patients appeared to be much lower. Peretz and colleagues not only included children, but also 60 Syrian adult patients who were treated at Baruch Padeh Medical Center in Israel in their study. Among these adult patients 11.7% (7/60) were colonized with ESBL-E. Why there is such a difference in ESBL-E carriage rates among Syrian refugee children and adults is not mentioned. It is also not mentioned why the percentages of ESBL-E colonization in these studies done in Israel are much higher than in the majority of the studies.

All other studies, except for the latter two, screened refugees from all over the world. What stands out is that the majority of the refugees originate from the Middle East and Africa, especially from Syria,
Afghanistan and Eritrea. The study done by Piso and co-workers (19) shows high percentages of colonization with ESBL-E in refugees originating from the Middle East. This study among 241 refugees from four Swiss refugee centers screened rectal swabs and urine samples on ESBL-E. The study found 23.7% (57/241) of the refugees to be colonized with ESBL-E, with significantly higher colonization in refugees originating from the Middle East compared to refugees from other regions. The colonization of ESBL-E in refugees from the Middle East was 35.1%, while all the other regions had colonization rates lower than 20%. The rates of ESBL-E colonization in the 10 articles (table 1) might be like this due to the limited scope of refugees from mainly the Middle East and Africa. If a bigger part of the refugees originated from other geographical locations than the Middle East and Africa, the rates might have been different.

In summary, around 30% of the refugees from all over the world coming to Europe were colonized with ESBL-E. By far, the most frequently reported ESBL-producing bacterial species was *E. coli*.

Table 1. Ten studies on the prevalence of ESBL-E colonization in refugees

<table>
<thead>
<tr>
<th>Study design</th>
<th>Location study</th>
<th>Native country</th>
<th>Size population</th>
<th>Sample method</th>
<th>ESBL-E colonization (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kassem, D. F., Hoffmann, Y., Shahar, N., et al. (2017). (17)</td>
<td>Cross sectional study</td>
<td>Israel</td>
<td>Syria</td>
<td>107</td>
<td>Screening: culture sites from nares, axilla, groin, rectum, and open wounds</td>
</tr>
<tr>
<td>Piso, R. J., Käch, R., Pop, R., Zillig, D., Schibli, U., Bassetti, S., Meinel, D. &amp; Egli,</td>
<td>Cross sectional study</td>
<td>Switzerland</td>
<td>A total of 24 nationalities. Most of the refugees originated from Afghanistan</td>
<td>241</td>
<td>Screening: rectal swab and urine sampling</td>
</tr>
<tr>
<td>Study Authors</td>
<td>Study Type</td>
<td>Country</td>
<td>Regions</td>
<td>Classifications</td>
<td>Screening Method</td>
</tr>
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<td>-------------------------------</td>
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</tr>
<tr>
<td>Ravensbergen, S. J., Lokate, M., Cornish, D., Kloeze, E., Ott, A., Friedrich, A. W., van Hest R., Akkerman O., W., de Lange, W., C., van der Wert, T., S., Bathoorn, E. &amp; Stienstra Y. (2016)</td>
<td>Cross sectional study</td>
<td>Netherlands</td>
<td>Eritrea, Syria, Afghanistan, Armenia, Nigeria, other in Africa, other in Asia, other in Middle East, other in Europe, other in South America &amp; unknown</td>
<td>Most of the refugees came from Eritrea (36.5%) and Syria (18.6%).</td>
<td>Swabs from nose, throat, rectum and perineum</td>
</tr>
<tr>
<td>Reinheimer, C., Kempf, V. A., Göttig, S., Hogardt, M., Wichelhaus, T. A., O'Rourke, F., &amp; Brandt, C. (2016)</td>
<td>Cross sectional study</td>
<td>Germany</td>
<td>Syria, Afghanistan, Somalia, Albania, Iraq, Eritrea, others &amp; unknown</td>
<td>Most of the refugees came from Syria (32.9%), Afghanistan (20.3%), and Somalia (9.8%).</td>
<td>Rectal swabs</td>
</tr>
<tr>
<td>Reinheimer, C., Kempf, V. A., Jozsa, K., Wichelhaus, T. A., Hogardt, M., O'Rourke, F., &amp; Brandt, C. (2017)</td>
<td>Cross sectional study</td>
<td>Germany</td>
<td>Afghanistan, Syria, Somalia, Algeria, Iraq, Pakistan, Eritrea, Ethiopia, Egypt, other &amp; unknown</td>
<td>Most of the refugees came from Afghanistan (25.6%) and Syria (24.8%).</td>
<td>Rectal and nasal swabs</td>
</tr>
<tr>
<td>Tenenbaum, T., Becker, K. P., Lange, B., Martin, A.,</td>
<td>Cross sectional study</td>
<td>Germany</td>
<td>Syria, Afghanistan, Iraq , the Gambia, Albania, Iran, Nigeria and from</td>
<td></td>
<td>Rectal swab</td>
</tr>
</tbody>
</table>

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Refugees compared to resident people and travellers
In order to place the carriage rates among refugees into context it is important to also know the baseline prevalence of ESBL-E carriage in Europe as well as the carriage rates of European travelers returning from regions such as the Middle East. Although ESBL-E carriage rates should ideally be as low as possible, the question is whether refugees really have a higher prevalence of ESBL-E than resident people and returning travelers. You never want someone to be colonized with ESBL-E, but do refugees really have a higher prevalence of ESBL-E than resident people and travelers? Several of the included studies (12-14, 16, 19) also investigated the prevalence of ESBL-E in other people than refugees. This may be helpful to see whether refugees really contribute to the import of ESBL-E in Europe compared to resident people and people traveling abroad.

Colonization of ESBL-E in refugees and resident people
In a German study (12) 119 refugee minors under 18 years old were screened for colonization with ESBL-E when arriving to the University Clinic of Frankfurt, between 12 October and 6 November 2015. They were screened with the use of stool samples. As can be seen in table 1 colonization with ESBL-E was detected in 35% (42/119) of the refugee minors of whom 37 carried ESBL-producing E. coli and 5 carried ESBL-producing K. pneumoniae. According to the authors, the percentage of 35% exceeds the prevalence in the German population up to 4 to 5 fold. In a large study on ESBL-E colonization among the German population itself, Valenza and colleagues (22) tested 3,344 persons residing in the southern part of Germany between 2009 and 2012. In this study 6.3% (211/3344) of the Germans were colonized with ESBL-E. In the Rhine-Main region in Germany, the prevalence for ESBL-E in the period from 2012 to 2015, were 7.5% in dialysis outpatients (23) and 7.7% in patients of rehabilitation clinics (24). Patients depending on ambulatory care or residing in elderly care homes however, were more frequently colonized with ESBL-E. In order to assess colonization rates of ESBL-E in nursing home residents perianal swabs were analyzed. Prevalence for ESBL-E in nursing home residents were 17.8% (25). By comparing the ESBL-E colonization rates of refugee minors from the study done by Heudorf et al. (12) and the ESBL-E colonization rates of other patient groups in the Rhine-Main region in Germany (22-25), the percentages of the refugees exceed those of the resident people (35%>17.8%). From these numbers we can conclude that refugees coming to Europe probably contribute to the import of ESBL-E.

A similar conclusion was drawn by Reinheimer and colleagues (13) based upon their study among 143 refugee patients admitted to the University Hospital of Frankfurt am Main in Germany in the period between June and December 2015. In this study 1489 resident patients admitted to ICU/IMC within the same period were included as comparison group. Of the 143 refugee rectal swabs 60.8% were positive for any multidrug resistant gram-negative bacteria. Of the resident people only 16.7% were positive for any multidrug resistant gram-negative bacteria. Among all the multidrug resistant gram-negative bacteria species, ESBL-producing E. coli were detected with higher prevalence in refugees than in resident people, with percentages of respectively 23.8% and 4.9%. Also the prevalence of ESBL-producing K. pneumoniae in refugees exceeded the prevalence in the resident people, with percentages of respectively 4.2% and 0.8%. Again the colonization of ESBL-E in refugees exceeds the colonization of ESBL-E in resident people, as it is mentioned in the study of Heudorf et al. (12).

Ravensbergen and co-workers (16) collected data from asylum seekers admitted to the Medical Center Groningen. In April 2014, the department of medical microbiology in the UMCG advised screening for multidrug resistant gram negatives for all asylum seekers admitted to the hospital or who presented at the emergency department. Screening consisted of swabs from nose, throat, rectum and perineum. If patients tested positive, they were isolated during their stay in the hospital according to national and local guidelines. The results of this study showed a
colonization rate of 31% for multi-drug resistant microorganisms, with ESBL-expressing E. coli (20/273) being the most common multidrug resistant microorganism with a percentage of 7.3. Research on the prevalence of colonization with ESBL producing Enterobacteriaceae was also done with 1025 Dutch adults, by Kraker and co-workers (26). Those Dutch adults were screened via rectal swabs. The overall colonization of ESBL-E in the Dutch population turned out to be 5.1% (52/1025). Again, the percentage of refugees exceeds that of resident people (31 > 5.1).

Colonization of ESBL-E in refugees and people from abroad
In a German study (14) conducted at the University Hospital Frankfurt 117 refugees, 84 patients admitted from health-care systems abroad as well as 495 resident patients admitted to intensive care unit without previous hospitalization abroad, were screened for multidrug resistant bacteria using rectal and nasal swabs. According to German infection protection law it is mandatory for hospitals to execute a documented infection control strategy intended to prevent the transmission of infective agents and their potential harmful consequences on patients’ health. At the hospital all patients admitted from hospitals from abroad or arriving from refugee accommodations are pre-emptively isolated and screened for multidrug resistant organisms on the day of admission. The screening procedure also applies to resident patients without a history of pretreatment abroad that are being admitted to an intensive care unit (ICU). Immediately after negative results for multidrug resistant organisms, patients are released from isolation. In case of a positive screening result for multidrug resistant organisms, patients will remain in isolation during their entire stay at the hospital. The percentage of E. coli expressing resistance due to ESBLs was 20.5% in refugees, 5.9% in patients hospitalized abroad and significantly lower with 2.8% in ICU patients. The percentage of K. pneumoniae expressing resistance due to ESBL was 2.6% in refugees, not detected in patients hospitalized abroad and significantly lower with 0.2% in ICU patients. So, it seems that refugees probably contribute more to the import of ESBL-E into Europe than patients hospitalized abroad and ICU patients. However, the patients hospitalized abroad did not cross the same countries as the refugees did. Most refugees came from Afghanistan (25.6%) and Syria (24.8%). Most abroad patients were hospitalized in Turkey (13.1%), followed by Greece, Italy, Morocco and Nigeria of which all contributed 4.8% to the total population. This shows that most abroad patients were hospitalized in European countries, while the refugee population consisted of only people coming from countries outside of Europe. Due to this it is not fair to compare the latter described populations. To be able to fairly compare refugees and people hospitalized abroad, more abroad patients hospitalized in countries outside Europe should be tested and compared to the refugees.

In the article of Piso and co-workers (19) a prospective study on travelers is mentioned. The mentioned study (10) was done with 179 travelers traveling from Switzerland to South Asia. In this study a pre- and post-travel faecal sample was provided. Of the 179 participants, 170 (95.0%) had a negative pre-travel screening for ESBL-E and only five (2.8%) had a positive screening. Furthermore pre-travel data was missing for four participants. This indicates again that the colonization of ESBL-E in refugees in Switzerland, which was found to be 23.7% in the study of Piso et al. as mentioned earlier (19), is higher than the 2.8% colonization of ESBL-E in the Swish population. However after return, the overall colonization rate in the study of Piso and co-workers (19) with ESBL-E was 69.4%. The highest rate of people non-colonized before the trip and colonized with ESBL-E immediately after they return was found in travelers returning from India (86.8%). The lowest rate of people non-colonized before the trip and colonized with ESBL-E immediately after they return was found in travelers returning from Sri Lanka (34.7%). This indicates that the colonization of ESBL-E in travelers traveling from Switzerland to South Asia is very high.

As all carriage rates among non-refugees as discussed above were derived from papers that mainly studied the carriage rates among refugees, there might be some deliberate or undeliberate underreporting of the ESBL-E rates among non-refugees. In order to get a better picture of the carriage rates among non-refugees more research was done. Other studies do show that the colonization of ESBL-E can be higher in travelers compared to refugees. One example of such an observational prospective cohort study (27) was done with individuals attending vaccination clinics in south-east Sweden, in which the submission of faecal samples and questionnaires before and after traveling outside Scandinavia was requested. Of the 262 enrolled individuals, 2.4% were colonized with ESBL-E before

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Among 226 evaluable participants, ESBL-E colonization was detected in 30% of the post travel samples. The most important risk factor in this study seemed to be the geographic area visited: Indian subcontinent, Asia and Africa north of the equator were major risk areas. This study clearly shows that colonization of ESBL-E can be high in travelers as well.

Another study (28) that also concludes that ESBL-E colonization can be high in travelers as well, screened 2001 Dutch travelers with the use of faecal samples and questionnaires on demographics, illnesses, and behavior. These were collected before travel and immediately and 1, 3, 6, and 12 months after return. Samples were screened for the presence of ESBL-E. 633 of 1847 (34.3%) travelers who were ESBL negative before travel and had available samples after return had acquired ESBL-E during international travel, with the highest number of acquisitions being among those who traveled to southern Asia in (75.1%). Again this study clearly shows that colonization of ESBL-E can be high in travelers as well.

Probably the studies used in the then articles are selected on the fact they show lower prevalence in resident people and travelers than refugees.

Recommendations

Six of the ten articles (13, 14, 17-20) on the colonization of ESBL-E in refugees recommend to isolate and screen refugees since those articles state that refugees are a risk for transmitting ESBL-E among other people.

Heudorf and colleagues (20) screened 290 refugees admitted to hospitals in the Rhine-Main region of Germany for the colonization with ESBL. 12.8% (7/290) of the 290 patients tested positive for colonization with any ESBL-forming bacteria (range 13.5–34.1% per hospital). The article included many other studies about the prevalence of ESBL-E in refugees, some of them are mentioned in this article as well.

One study included is done by Peretz and colleagues (18). This study states that due to the high colonization rate of multidrug resistant isolates, contact isolation of Syrian patients is needed, until carriage of multidrug resistant isolates is ruled out. The article states this is the way to prevent further spread of these pathogens. Although criticized by Walter and colleagues (29), Peretz and colleagues (18) demanded pre-emptive isolation in hospitals, which has been implemented in the Frankfurt am Main University Clinic “as the best medical practice and safety for all patients regardless of their country of origin”.

However the study done by Steger et al. (21) doesn’t recommend to isolate and screen refugees. In this study 99 refugees were screened for colonization with MRGN / ESBL via rectal swabs at the hospital in Ingolstadt. Eight patients (8.1%) were colonized by E. coli exhibiting extended spectrum beta-lactamase activity. This percentage is similar to that of German ambulatory patients. So, the percentage of refugees colonized with multi-resistant bacteria was low, eliminating the necessity of general screening measures at hospital admission. This study shows that the rate of refugees colonized with multi-resistant bacteria in Ingolstadt is relatively low at present and there is no reason to assume threat to the local population.

Discussion

Although most of the above articles clearly state it would be helpful to screen or isolate refugees, there are still some doubts. All ten articles on the prevalence of ESBL-E in refugees were retrospective studies and to get to know whether the colonization rates of ESBL-E are really as high as stated in the articles more prospective studies are needed. Since ESBL isolates in none of the studies were available for WGS typing, person to person transmission within a center can’t be definitely ruled out. This would mean that part of the refugees may have acquired ESBL-E in a German refugee center and not in their home country. Especially since many refugee camps are overcrowded and unhygienic, increasing the risk of transmission. Unfortunately, information regarding refugees’ itineraries weren’t available in the studies due to missing records in the patient files and the language barrier on hospital admissions. However, such information would help to better understand the origin and transmission routes of ESBL-E.

Some people may think it would be a good idea to screen refugees when admitted to a hospital. But some may have their doubts. Probably there are too many stigmas on the refugees. People often think refugees contribute more to the transmission of ESBL-E in Europe than for instance travelers do. But do refugees really contribute that much to the import of ESBL-E into Europe? Isn’t it unfair to only screen refugees while many other patients may be colonized with ESBL-E as well? A key problem is that refugees get stigmatized for carrying ESBL-E and that might mean
they do not want to approach doctors or international organizations and present the illness. Also the resident people might fear refugees around them, because they are scared of acquiring ESBL-E due to the presence of refugees. By screening refugees many people think the transmission of ESBL-E will be prevented. However, the increased costs of screening and limited isolation capacities in hospitals have to be weighed against potential stigmatization and poorer patient care.

Moreover, decolonization strategies in refugees may not work well due to suboptimal conditions in refugee camps where overcrowding and language barriers to understanding medical indications are often present. Therefore, there are doubts whether screening and isolation policies already seen in hospitals in Germany and the Netherlands are helpful. It’s probably not fair to only screen refugees (stigma), but screening everyone is not achievable.

More prospective studies on the contribution of refugees to the transmission of ESBL-E to Europeans have to be done. In the discussed studies most refugees were screened due to admission to hospital. In many of the above studies refugees were pre-emptively isolated and screened for multidrug resistant organisms on day of admission. That may also be the reason why many of the studies are done in Germany. Because according to the German infection prevention law (“Infektionsschutzgesetz”) it’s mandatory for hospitals to execute a documented infection control strategy to prevent the transmission of infective agents, to prevent the possible potential harmful consequences on patients’ health. But due to the fact that many of these studies were done with patients admitted to a hospital it should be questioned whether this population is a good representation of the overall refugee population. Because next to refugees admitted to a hospital many other refugees are present. And only checking refugees admitted to hospital is not fair, since no good representation of the overall refugee population will be achieved.

Finally longitudinal studies have to be done with refugees as well. The ten studies mentioned in this article only screened for ESBL-E colonization rates, but didn’t investigate how long those refugees were colonized. To be able to see to what extent refugees contribute to the ESBL-E import to Europe it’s important to see for how much time these refugees are ESBL-E positive. If they only are colonized for a very short time, the danger of transmission would be much smaller than if they were colonized for a very long time. So the time of colonization with ESBL-E should definitely be investigated in studies as well.

Conclusion
Despite a high variability in the prevalence of colonization with ESBL-E in refugees, refugees might contribute to the import of ESBL-E in Europe. Right now, it is still unclear to what extent refugees carry and import ESBL-E into Europe. It is unknown whether the colonization rates of ESBL-E in refugees are higher than in resident people and travelers, since studies show different results. As this is still not clear, screening or isolating refugees coming to Europe is not useful. Infection prevention and control policies are only helpful if the biggest risk factor is eliminated.

More prospective, longitudinal studies with hospitalized and non-hospitalized refugees have to be done to investigate a better represented group of refugees and to know where those refugees acquired ESBL-E and for how long they acquired it.

Literature
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