Pharmaceuticals and the Environment
- Physicians Role in the Dissemination of Information

Hannah Floer Miller

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Abstract
Pharmaceuticals have been gaining environmental attention on a global scale. It is estimated that approximately 4,000 medical compounds are used in the drugs applied today. As middle hand providers, licensed physicians are the third to last representative in the distribution chain of prescription drugs. The aim of this study was to examine if Swedish and Danish physicians consider environmental effects of the products that they prescribe and if there is a difference between the environmental considerations being taken today. Interviews with 24 medical participants have been conducted.

Physicians are environmentally aware. They do think about the fact that the products they are prescribing do have potential negative effects on the environment. They already disseminate information to patients about antibiotics and to some extent the importance of returning discarded pharmaceuticals to the pharmacy. Physicians could, with the right foundation of environmental information and support, disseminate important environmental information to patients.
Introduction

Chemicals are a large part of daily lives. It is estimated that 70,000 to 100,000 chemical substances are in commerce in Europe alone today. We use chemicals in many different ways and for many different reasons. They are emitted into our environment in one form or another with outcomes that we know little about. Of particular concern is their exposure to humans and animals.

One important group of chemicals that has been gaining environmental attention on a global scale is the group commonly referred to as Pharmaceuticals and Personal Care Products (PPCPs). According to the American EPA this group refers, “in general, to any product used by individuals for personal health or cosmetic reasons or used by agribusiness to enhance growth or health of livestock. PPCPs comprise a diverse collection of thousands of chemical substances, including prescription and over-the-counter therapeutic drugs, veterinary drugs, fragrances, and cosmetics.”

Pharmaceuticals have gained environmental interest because they are biologically active, often mobile due to their water solubility and not readily biodegradable. Pharmaceuticals are important to many peoples health around the world. Not only do they help people to maintain adequate health, they save lives. At the same time more studies are proving that pharmaceuticals also have negative effects on the environment. This is a conflict that should be addressed sooner rather then later as human health is also strongly linked to the health of the environment.

Pharmaceutical Products (PPs) for human use, which according to WHO are “more commonly known as medicines or drugs – are a fundamental component of both modern and traditional medicine. It is essential that such products are safe, effective, and of good quality, and are prescribed and used rationally”. It is estimated that approximately 4000 medical compounds are used in the drugs applied today. The worldwide consumption of active compounds is estimated to 100,000 tons per year.

PPs consist of many different ingredients and chemical forms (molecules, proteins, carbohydrates). They are developed to have different chemical properties such as acidic, basic or neutral and thereby react in the body in a variety of ways. Of interest in this study are those ingredients that are referred to as active pharmaceutical ingredients (APIs) and excipients. All pharmaceuticals contain at least one active ingredient, which is what gives the product its’ characteristics and thereby its’ affects both inside and outside the human body. An API is defined by the US FDA as “any substance or mixture of substances intended to be used in the manufacture of a drug product and that, when used in the production of a drug, becomes an active ingredient in the drug product. Such substances are intended to furnish pharmacological activity or other direct effect in the diagnosis, cure, mitigation, treatment or prevention of disease or to affect the structure and function of the body.” An excipient is according to the free medical dictionary “any more or less inert substance added to a drug to give suitable consistency or form to the drug; a vehicle.” In other words, excipients have several functions such as binding, filling, viscosity modifiers, absorption enhancers, etc.
The main focus of this project is on the pharmaceutical group referred to as prescription drugs, which according to the free dictionary is “a drug that can be dispensed to the public only with an order given by a properly authorized person. The designation of a medication as a prescription drug is made by the U.S. Food and Drug Administration”.

Licensed physicians prescribe prescription drugs to patients. In this project I refer to physicians as “middle hand providers of (prescription) pharmaceuticals”. They do not produce or consume the products at question. They prescribe the producer’s products to the consumers (patients).

The aim of this pilot project is to answer one main research question and three sub questions, which are found below. To answer these four questions interviews with 24 medical participants, both experienced and newly educated, have been conducted and their answers have been studied and compared.

The main research question and three sub questions:

1) Do Swedish and Danish physicians consider environmental effects of pharmaceuticals when prescribing pharmaceuticals?

a) Is there a difference in the environmental considerations being taken by Swedish educated physicians and Danish educated physicians?

b) Is there a difference in the considerations being taken between newly educated physicians and more experienced physicians?

c) Is there a difference in the environmental considerations being taken by the physicians who are employed by an ISO 14001 certified organization and a public health care provider that has not implemented an environmental management system?
Background

There are two main pathways for pharmaceuticals and their compounds to enter the environment, which are illustrated in Figure 1 below. One pathway is through excreting. Pharmaceutical compounds once administered, exit the body as the parent compound and/or metabolites in urine and feces. Once excreted, they enter municipal sewage treatment systems or other receiving water bodies. There they can either stay in the same form or be broken down, adsorbed to sewage sludge, and/or eventually diluted into surface water. The other pathway is through disposal of unwanted medications in solid household waste, or through household sewage systems. Both pathways have an end point in water recipients where there is potential threat to aquatic organisms. Studies have found pharmaceutical substances in fish due to bioaccumulation in the aquatic ecosystem. Some pharmaceutical substances have been detected in ground water as well as treated surface waters.

Today there are approximately 160-180 active pharmaceutical ingredients (API) found in our water environment. These substances have been found in outlets from wastewater treatment facilities, surface, ocean and groundwater’s as well as in drinking water and in leakage from dump yards. They have also been found in the Antarctic environment.

The pharmaceuticals classes that are of specific environmental concern are listed below:

- Antibiotics
- Antidepressants
- Antiepileptic drugs
- Antimicrobials
- Calcium-channel blockers
- Estrogenic steroids

- Genotoxic drugs
- Multi-drug transporters
- Musk fragrances

Figure 2 Two main pharmaceutical pathways into the environment. Illustration by Malik. S.
Although more studies and reports are for coming about the presence of pharmaceuti-
cals in the environment, there is still a lot that we lack knowledge of. Metabolites are
not well studied nor are the effects on water organisms, caused by cocktail mixtures
of different chemicals and their synergetic effects.xxviii There is also little known about
long term effects on ecosystems due to the presence of cocktail mixtures under longer
time periods.

**Environmental Regulations of Interest within this Project**

Once a potential pharmaceutical drug for human use is discovered, purified, and char-
acterized it must go through pre-clinical studies. These consist of laboratory tests that
are conducted in test tubes and on cell cultures (in vitro) as well as on living animals
(in vivo). After the drug proves to meet all the requirements and demands of the Pre-
clinical stage it continues to the next steps found in the so-called Clinical stage. This
stage consists of a set of procedures, which are referred to as the clinical trials. The
clinical trials consist of five phases, with means to research how the drug reacts in the
human bodyxxix. The clinical trials five phases are briefly described below.

**Phase I:** The initial administration of an investigational new drug into humans. This is
the first stage of testing on humans. Typically a group of healthy volunteers or certain
types of patients are tested. The means of this stage is to examine four main aspects of
the drug:

- How safe the drug is (pharmacovigilance) and how the human body reacts to the
drug (tolerability)xxx
- how the drug reacts in the body (pharmacokinetics)xxxi
- how the drug effects the body (pharmacodynamics)xxxii
- how active the drug is in the body (drug activity)xxxiii

**Phase II:** Typically therapeutic exploratory studies are performed with means to de-
termine how well the drug works on the patients’ specific health problem. A group of
specifically picked patients are tested. The means of this stage is to determine the
dose(s) and regimen for the next phase.

**Phase III:** Typically therapeutic confirmatory studies are performed with the means to
prove that the drug will work as it was intended. The objective of this stage is to pro-
vide marketing information about the drug, for approval in the next stage.

**Phase IV:** This last phase does not start until after the drug’s approval. A variety of
studies to determine the drug’s therapeutic use are performed. The objective of this
stage is to examine how to optimize the drug.

Special considerations are to be included in studies on drug metabolites, drug-drug
interactions (cocktail effects) and on special populations are highly recommended.xxxiv

Pharmaceutical producers are to perform an environmental risk assessment on their
products in order for the product to be marketed within the European Union, accord-
ing to the Commission Directive 2003/63/EC.

The European Water Framework Directive (WFD) (2000/60/EC) is a legislative
framework with means to protect and improve the quality of all water sources, which
includes lakes, rivers, transitional and coastal waters, and groundwater within the European Union.

The treatment of waste is regulated through Directive 2008/98/EC. Its means is to protect the environment and human health through prevention of harmful effects of waste generation and management.

Chemicals and their safe use are regulated through the European Community Regulation EC 1907/2006 so called REACH. REACH aims to improve the protection of human health and the environment through registration, evaluation, authorization and restriction of chemical substances and puts more responsibility on the producers. PPs are regulated through the European Medicines Agency.

Antibiotic resistance
Pharmaceutical antibiotics are designed to attack unwanted bacteria in humans, animals and on plants. They do not break down easily inside of the host, nor do they break down easily in nature. The widespread use of antibiotics started in 1950. Since then, antibiotics have been emitted as active substances into the environment mainly through excretion. Because of their chemical structure and the biological structure of bacteria, the occurrences of antibiotic resistant bacteria have become a worldwide problem today.

There is an ongoing project within EU to help tackle the antibiotic resistance dilemma. The project is called APRES and has the means to develop appropriate guidelines for prescribing antibiotics within Europe by the end of 2013.

Sweden
In Sweden there is The Environmental Code, which is a gathering of environmental legislation. Chemicals in general are regulated through the Swedish Chemicals Agency (KemI). PPs are regulated through the Swedish Medicinal Products Agency (Läkemedelsverket). Sweden also has a total of 16 national environmental objectives set to be reached in 2020, seven (4, 8, 9, 10, 13, 15, & 16) of which fall into interest when it comes to chemicals (pharmaceuticals) presence in the environment.

FASS is a database for information on pharmaceuticals that are approved of in Sweden. It consists of three levels of information meant for general public, human pharmaceutical prescribers, and veterinarian pharmaceutical prescribers. It includes environmental classifications and information about pharmaceuticals. It also sets such guidelines for pharmaceutical producers. As of today there are approximately 200 pharmaceutical substances classified with environmental information.

Denmark
Environmental laws in Denmark are found within the Danish Environmental Protection Agency. The agency has four main focus areas; Recycling and Waste, Sustainable Consumption, Living with Chemicals, and Eco-technologies. PPs are regulated through the Danish Medicinal Agency (Lægemiddel Styrelsen).

IRF.dk and medicin.dk are the two pharmaceutical information databases available in Denmark. Neither of the websites seems to provide environmental information about
pharmaceuticals.

**Environmental Information Sources within Primary Health Care**

Environmental databases of all different sorts are becoming more common and available to the general public. They are found on websites of Environmental Protection Agencies, Government officials, worldwide foundations and many more. Two databases that fall into the interest of this study are the Medicinal Agencies found in Denmark, EU, and Sweden as well as REACH and FASS, which are mentioned above.

Environmental education is an important source of environmental information. Most health care providers lack environmental education. Environmental management programs tend to recommend educational courses as a means of environmental information.

Although media is not a specific information source within primary health care it is a large source for environmental information for many Danish and Swedish citizens. Environmental issues started gaining attention in the Swedish media year 2000, and had its major breakthrough 2005. Since then, many environmental issues have been brought to the eye of the general public. Although the media might not always have their facts straight, the general public’s main source of information about environmental issues comes from the media.

Other sources of environmental information can be provided within environmental educations, information papers from different providers such as employers, product producers, government and more, information meetings and discussions with coworkers.

**Medical education in Denmark and Sweden**

Like in many other countries around the world it is the physicians in Sweden and Denmark who have full responsibility to prescribe pharmaceuticals in the respective countries. This means that a patient can only get prescription drugs (legally) through a licensed physician in either of the two countries. In order for physicians to be able to perform their duties they must complete 7 years of intense medical education. Unfortunately as of today there is no environmental education provided within the base block of medical school in either of the two countries. There are some courses that bring up the environment within pharmacology but these courses are not mandatory for medical students. The fact that physicians are not provided with environmental education before they receive their medical license leaves reason to question the following; do Swedish and Danish physicians consider environmental effects of pharmaceuticals when prescribing pharmaceuticals?

The medical education provided in Sweden differs to some extent from the medical education provided in Denmark. Amongst other differences, there is no pharmacology course provided within the medical base block in Swedish universities. Instead pharmacology is found within some of the individual courses that are provided within the medical base block, so-called holistic studies. In Denmark, pharmacology is provided as a smaller course within the medical base block. This fact leaves reason to question; is there a difference in the environmental considerations being taken by Swedish educated physicians and Danish educated physicians?
Environmental awareness is growing in both the Swedish and Danish society. Because there is no environmental education included within the medical educations provided in Sweden or Denmark leaves reason to believe that physicians environmental awareness originates from different sources other then the standard (base block) education provided. Because younger people have the tendency to “soak-up” more “outside” information then what elderly do it is highly interesting to question the following; is there a difference in the considerations being taken between newly educated physicians and more experienced physicians?

Certification of environmental management system

In Southern Sweden, Skåne, there are a few different public health care providers. Some of the providers have a certified environmental management system according to ISO 14001 standard. The standard bases on a method called “Plan-Do-Check-Act”. A few of the subjects of importance within ISO 14001 are communication and education. For further details about ISO 14001, please visit the International Organization of Standardization homepage. With an environmental management system in place, one would think that environmental aspects are perhaps more highlighted within an ISO 14001 certified clinic rather than in a clinic that is not ISO 14001 certified. This leads to the last sub question; is there a difference in the environmental considerations being taken by the physicians who are employed by an ISO 14001 certified organization and a public health care provider that has not implemented an environmental management system?
Method

To answer the research questions mentioned above oral interviews were conducted with 24 individuals. For comparison reasons the participants have been divided into two main groups, Group 1 and Group 2. Both of the main groups (1&2) are divided into subgroups (a, b & c). Group 1, consists in total of 10 medical interns and Group 2, consists in total of 14 experienced physicians. See below.

The two main groups (1, 2) with each of their subgroups (a, b, c) and the amount of participants in each group are listed in Table 1 below:

Table 1 The two main groups and the five subgroups within this study, “Sw Phys EMCC” stands for Physicians who are employed at a clinic that is environmentally certified according to ISO 14001. “Sw Phys NEMCC” stands for Physicians who are employed at a clinic that is not ISO 14001 certified. “Danish Physicians” stands for Physicians who are employed at a clinic in Denmark.

<table>
<thead>
<tr>
<th>Group Title</th>
<th>Subgroup</th>
<th>Subgroup Name</th>
<th>Amount of Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Medical Interns</td>
<td>a</td>
<td>Swedish Interns</td>
<td>5</td>
</tr>
<tr>
<td>1. Medical Interns</td>
<td>b</td>
<td>Danish Interns</td>
<td>5</td>
</tr>
<tr>
<td>2. Experienced Physicians</td>
<td>a</td>
<td>Sw Phys EMCC</td>
<td>5</td>
</tr>
<tr>
<td>2. Experienced Physicians</td>
<td>b</td>
<td>Sw Phys NEMCC</td>
<td>4</td>
</tr>
<tr>
<td>2. Experienced Physicians</td>
<td>c</td>
<td>Danish Physicians</td>
<td>5</td>
</tr>
</tbody>
</table>

Interns: in this study “Interns” refers to medical students who are performing their pre-registration physician period at a public health care provider or hospital. The pre-registration period in Sweden is a minimum of 18 months and in Denmark 12 months. Interns are not allowed to prescribe patients with pharmaceuticals but they do practice this duty under the supervision of a licensed physician. They will soon be performing the duty on their own and are therefore of particular interest for this study. Interviews were conducted with two sub groups of interns, five individuals who have received their medical education in Sweden (“Swedish Interns”) and five who have received their medical education in Denmark (“Danish Interns”).

Experienced Physicians: in this study “Experienced Physicians” refers to physicians with 10 or more years of medical experience. Interviews were conducted with three groups of experienced physicians; 9 individuals who are employed in Sweden, five of which are employed by an ISO 14001 certified public health care provider (“Sw Phys EMCC”) and four individuals that are employed by a health care provider that is not ISO 14001 certified (“Sw Phys NEMCC”). The third group consists of five physicians employed as or at a public health care provider in Denmark (“Danish Physicians”).

The Questionnaire

The questionnaire was built and reviewed by a medical intern, my academic adviser and the commissioning body. The commissioning body was delayed in their response, which had minor effect on the study. (Two questions were added to the questionnaire after the interviewing period had started.) Interviews conducted with the first three participants did not include the two additional questions. See “Discussion” for further detail.
The questionnaire is divided into three sections and consists of 21 questions in total. The sections are as followed, "General Questions”, “Pharmaceuticals and the Environment” and “Waste, Start Packages and Other”. A full version of the questionnaire is found in Appendix 1.

"General Questions” consists of four questions. The objective of this section was mainly to get acquainted with the participant and to see if they found themselves to be environmentally aware or not.

“Pharmaceuticals and the Environment” consist of ten questions. There were several objectives to this section. The main objective was to find out if the participant was aware of the available environmental information that is provided to them today, if they use it and how they valuate the information. Another objective was to determine if the interviewee could see pharmaceuticals in the “whole environmental picture” meaning how pharmaceuticals are emitted, possible effects, and what the concern about their presence in the environment is. Another point with this section was to find out if they feel they have enough support from their employers in the subject.

“Waste, Start Packages and Other” consist of seven questions. The main objective of this section was to find out if the participant disseminates wide spread information (pharmaceutical waste management and the antibiotic dilemma) to patients and to see if the participant thinks that the “Free card system” and “generic exchange system” that is available in both countries, contribute to increased pharmaceutical waste.

Participants

Participants were found mainly through personal net working and what is referred to as “Snowball sampling”. I found at least one participant representing each group and that participant helped find the rest of the participants in each group. The “Swedish Interns” have studied at one of the following universities, Lindköping, Lund or Umeå. The five “Danish Interns” have studied at the university of Copenhagen. All of the participants representing “Sw Phys EMCC” in Group 2a were attained through the help of the company Medical Advisor/Chief Doctor. These five participants have studied at one of the following universities, Göteborg, Lund and Debrecen (Hungary). The Chief Doctor of the health care provider that is not ISO 14001 certified helped find one representative of group 2b “Sw Phys NEMCC”. See “Results” for further details. The four participants in this group have studied at one of the following universities, Göteborg, Lund and Bergen (Norway). All of the participants within group 2c “Danish Physicians” were found through personal contacts. They have studied at one of the following universities, Copenhagen and Odense. All of the participants in this study are anonymous.

Interviews

Interviews were conducted in person (four participants in subgroups “Danish Interns”, “Danish Physicians” and “Sw Phys NEMCC”) or by phone (20 participants). Interview time ranged between 13 and 90 minutes, depending on the participant and how much they were willing to conversation. See “Discussion” for further detail.

All of the participants were asked questions 1-18 and question 21. Three of the participants were not asked question numbers 19 and 20 due to the delayed request by the commissioning body of adding two additional questions to the questionnaire.
The interviews were mainly conducted in Swedish. When needed, English was used. When interviewing Danish-speaking participants, the interviewee often repeated the asked question back to me. If I felt that there was a misunderstanding the question was re-asked in English.

Methods for particular questionnaire questions
Some of the questionnaire questions (3, 5, 9, 10, 11, 14, 15, and 17) were broad and thereby allowed a variety of answers. In order to keep within the limits of this project, I needed to come up with specific methods to be able to present the participants answers. The specific methods are presented below in the number order according to the questionnaire. The remainder questionnaire questions (2, 6, 7, 8, and 13) used in this study are presented in “Results”. As mentioned before, a complete version of the questionnaire can be found in the “Appendix 1”. The questionnaire questions 3-11 and 14-18 were used to answer the research questions of this project.

Question 3: Do you find the environment to be an important factor for people’s health? If you do, which environmental factors do you feel are of most importance?
All of the participants answered, “Yes” to the first part of this question and some were very clear in their answer such as one of the Danish Interns who said, “Yes a toxic-free environment meaning pollution in every form”. Not all of the participants answers were as clear and a variety of “environmental factors” were given such as “To come outside and see the nature”, “Sun and fresh air”, “Car pollution which leads to asthma”, “Global warming”, “Hormones in plastics”, “Antibiotic resistance”, “Clean water”, “Waste”, “CO2 emissions”, “Nuclear power”, “Children and early puberty”. To simplify the study, all of the factors given were studied and placed into three groups of scientifically defined environmental factors: “Clean water”, “Clean air”, and “Non-toxic environment” which are presented in Figure 4a in “Results”.

As mentioned in “Background”, there are two main ways that pharmaceuticals are emitted into the environment, through secrete and disposal. It is therefore interesting to see if the participants gave these pathways as an important environmental factor or not. I have therefore studied each individual answer and placed each in one of two groups: “Pharmaceutical pathway factor” and “Environmental factor”. Factors given that have to do with a pharmaceutical’s direct pathway into the environment (water or waste) were placed into “Pharmaceutical Pathway Factor”. Other environmental factors given that do not have to do with a direct pharmaceutical pathway into the environment (air, climate change, radiation, nuclear power, stress) were placed into “Environmental factor”. The results are presented in Figure 4b.

Question 5: How do you reason when I ask you to think about the connections between the use of pharmaceuticals and environmental effects?
The participants gave a variety of answers which I’ve called reasoning. The three reasoning’s are defined as followed:

No reasoning: The participant gave no reasoning such as “Never thought about it” or “I don’t know about the effects”.

Simple reasoning: The participant mentioned only one to two of the following reasoning’s: “International production, medicinal use after recommendation, usage of more effective medicines, waste management, antibiotic resistance, hormones, or veterinary medicines”. By giving only one or two of the above doesn’t clarify if the participant is
aware of the whole environmental picture, meaning how pharmaceuticals are emitted into the environment and the potential effects of this matter.

**Complex reasoning:** The participant was able to define both pathway and potential environmental effects of pharmaceuticals in the environment. Some of the complex reasoning’s given where, “secrete of metabolites that enter waste water treatment facilities and emitted into the water environment which can effect water life”, “Water and ground containment due to metabolites and or waste- we need to develop pharmaceuticals with less environmental impact (Green Pharma)”, LCA (Life cycle analysis) of pharmaceuticals (from production to the metabolites emitted into natural waters), “Re-develop the way the pharmaceutical works in- and outside of the body” (Green Pharma), or “Effects on water organisms that end up effecting the whole food-chain”. The results of this question are presented in Figure 5.

**Question 9:** How do you get environmental information about pharmaceuticals? Choose one or more of the alternatives below.

Six alternatives were provided in the questionnaire a) Informative databases, b) Education/course, c) Information papers, d) Information meetings, e) Articles in mass media, f) Discussions with colleges, and an additional two g) Other and h) None were added within the first two conducted interviews. The participants could choose one or more of the given alternatives. Of interest is to find out which of the given alternatives are the main sources of environmental information used by physicians. The results are found in Figure 9.

**Question 10:** Do you consider pharmaceuticals environmental effects when prescribing them? If not, what is that keeps you from doing so?

It is of interest to find out if the participants consider environmental effects of the pharmaceuticals they prescribe. The participants could choose one of two alternatives, yes or no. If they chose “no” then it was of interest to find out why. The three following reasons were given to why not, lack of knowledge, lack of time and not prioritized. The results from this question alone were used to answer the main questions of this study. See Figures 10a and 10b under “Results”.

**Question 11:** Do you actively search for environmental information about pharmaceuticals that you prescribe?

It is of interest to find out if any of the participants search for environmental information about the products that they prescribe. The participants could choose one of two alternatives, yes or no, see Figure 11a. If they chose “no” then it was of interest to find out why. The three following reasons were given to why not, lack of knowledge, lack of time and not prioritized, which are presented in Figure 11b.

**Question 14:** Who do you feel should be responsible for spreading environmental information about pharmaceuticals to patients? Choose one or more of the alternatives below.

As the middle providers of pharmaceuticals, physicians play an important roll in the distribution chain. Seven options were included in the questionnaire question, a) Physicians b) Pharmacist c) Patient d) Pharmaceutical companies e) Government/ County council f) Environmental authorities g) Other h) All. There are several interests within this question but only two of which will be brought up in this project. One is to find out who the participants think should be responsible for spreading environmental information to patients, see Figure 13 in “Results”. The participants could pick one or
more of the given options whereas option h includes all the options. As there was a
chance that the participants would pick more than one option, I was also interested in
which order they felt the responsibility should lay.

**Question 15: Do you inform patients about the importance of returning un-used
medication back to the pharmacy?**
Waste management is an issue that is highly discussed in both Denmark and Sweden.
Four options were given to answer question 15, always, often, sometimes or never. Of
interest is to find out if and how the participants take responsibility to inform patients
about a well-discussed and regulated environmental issue. See Figure 14 in “Results”.

**17 Method: The issue with antibiotic-resistant microorganisms is important for
both people’s health and the environment. How do you look upon this issue and
how do you handle it in your professional roll?**
The antibiotic resistance dilemma is highly discussed both within and outside of
healthcare. Of interest is to find out if the participants take to the information and
what recommendations they follow.

**Measuring Method for the Research Questions**
As said before the questionnaire questions 3-11 and 14, 15, and 17 were used to an-
swer the research questions of this project. Comparisons were made within and or
between the two main groups, Medical Interns and Experienced Physicians. A \( \chi^2 \)–
test (CHI2-test) was conducted on the results used to answer if there is a difference
between Danish and Swedish educated physicians as well as if there is a difference
between newly educated and experienced physicians. The results from the remaining
questionnaire questions (# 2, 13, 16, and 19-21) were studied and used as a foundation
in the further suggestions that are found in the “Discussion”.

To answer if *Swedish and Danish physicians consider environmental effects of phar-
macuticals when prescribing pharmaceuticals* the answers from all of the partici-
pants were used. The answers to the questionnaire question 10 were used for this
comparison.

To examine if there is a difference in the environmental considerations being taken
between newly educated physicians and more experienced physicians the results from
Group 1 and Group 2 were compared. The answers to questionnaire questions 3, 5, 9,
10, 11, 14, 15, 17, and 20 were used. A \( \chi^2 \)–test was conducted.

To examine if there is a difference in the environmental considerations being taken by
the physicians who are employed by an ISO 14001 certified organization and a public
health care provider that has not implemented an environmental management system,
results from the Experienced Physicians (“Swe Phys EMCC”) and “Sw Phys
NEMCC” within group 2 were compared. The answers to the questionnaire questions
3, 5, 6, 8, 9, 10, 11, 15, and 17 were used for comparison.

To examine if there is a difference in the environmental considerations being taken by
Swedish educated physicians and Danish educated physicians results within Group 1
and Group 2 were compared. The answers given to the questionnaire questions 3, 5, 6,
7, 9, 10, 11, 15, and 17 were used for comparison. A \( \chi^2 \)–test was conducted.
Results

In this project there are two different results to be presented. First there are the answers given by the 24 participants to the questionnaire questions and secondly the answers to the research questions of this project. As mentioned, specific questionnaire questions (3, 5, 7, 9, 10, 11, 15, and 17) have been selected to interpret the answers to the research questions. Not all of the questionnaire questions were used in this study and therefore not all of the given answers are presented in this section. See “Discussion” for the questionnaire answers not presented in this section.

Questionnaire Questions and Answers

The questionnaire questions (2, 3, 5, 6, 7, 8, 9, 10, 11, 13, 14, 15, and 17) and the answers are listed and illustrated below.

**Question 2)** Do you find yourself to be more or less environmentally aware in your private life now than what you were ten years ago? What’s the reason of change?

a) More environmentally aware  
b) Less environmentally aware  
c) Unchanged environmental awareness

As shown in Figure 3, 20 participants found themselves to be more environmentally aware today than 10 years ago, 15 of which said this was mainly due to the political discussions brought up in the media. Other reasons given were ecological food and products, antibiotic resistance, community involvement and “Because I have been able to see environmental changes with my own eyes”. Three of the interns found their awareness to be unchanged and one intern found his awareness to be less with the reason of having little interest in the subject.

**Question 3)** Do you find the environment to be an important factor for people’s health? If you do, which environmental factors do you feel are of most importance?

All 24 of the participants answered “Yes” to this question. Out of the three options presented in Figure 4a, six “Interns” and five “Experienced Physicians” answered an environmental aspect that has been
classified as “Non-toxic environment”. Six “Interns” and six “Experienced Physicians” answered an aspect that has been classified as “Clean water”. Four “Interns” and five “Experienced Physicians” gave an answer that has been classified as a “Clean air”.

As shown in Figure 4b, 10/10 “Interns” and 9/14 “Experienced Physicians” answered an important environmental factor that is a pharmaceutical pathway into the environment (water or waste).

Question 5) How do you reason when I ask you to think about the connections between the use of pharmaceuticals and environmental effects?

Three classes of reasoning, which are explained in “Method”, were given during the interviews. As shown in Figure 5, three of the Swedish Interns gave a simple reasoning and two gave a more complex reasoning around this question. Three of the Danish Interns were not able to give any reasoning and two gave a more complex reasoning. Two Experienced Physicians employed at ISO 14001 certified Swedish clinics gave a simple reasoning and three gave a more complex reasoning. All four of the Experienced Physicians employed at Swedish clinics that are not ISO 14001 certified gave a more complex reasoning. Four of the Experienced Physicians working in Danish clinics gave a more complex reasoning and one gave a simple reasoning around this question.

Question 6) Do you feel that you have enough information/knowledge in your professional roll, when it comes to understanding the interaction between pharmaceuticals, the environment and health?

a. Yes
b. No
As illustrated in Figure 6, two of the participants said that “Yes” they do feel that they have enough information in their professional roll when it comes to understanding the interaction between pharmaceuticals, the environment and health. 22 answered “No” to this question.

**Figure 6** Enough environmental information/knowledge in the professional roll.

**Question 7)** Do you feel that you have received enough knowledge about pharmaceuticals and their environmental effects during your base education of medical school to be able to:

- a) Understand the connections between usage of pharmaceuticals and their effects on the environment?
- b) Look up environmental information about pharmaceuticals?
- c) Inform patients about potential environmental effects of pharmaceuticals?

As shown in Figure 7, all 24 participants answered “No” they do not feel that they have received enough knowledge during their base education of medical school about pharmaceuticals and their environmental effects.

**Figure 7** Enough environmental knowledge from base education
Question 8) Do you feel that after your education have gotten enough support from your employer (education, information, time, etc.) to develop your knowledge of pharmaceuticals environmental effects?

As shown in Figure 8, three of the experienced participants feel that they get enough support from their employers when it comes to developing their knowledge of pharmaceuticals environmental effects. 21 of the participants do not feel that they get enough support in the matter.

Question 9) How do you get environmental information about pharmaceuticals? Chose one or more of the alternatives below.

a) Informative databases: FASS
b) Education/course
c) Information papers
d) Information meetings
e) Articles in mass media
f) Discussions with colleagues
g) Other
h) None

As shown in Figure 9 above, databases are used by 13 of the participants as a source for environmental information, followed by articles in mass media and information papers. In Table 2 below the total amount of options picked by each subgroup along with most chosen option by each group is listed.

<table>
<thead>
<tr>
<th>Mini Group</th>
<th>Total Options Picked</th>
<th>Most Chosen Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swedish Interns</td>
<td>4</td>
<td>a &amp; c</td>
</tr>
<tr>
<td>Danish Interns</td>
<td>4</td>
<td>a</td>
</tr>
<tr>
<td>Sw Phys EMCC</td>
<td>6</td>
<td>d</td>
</tr>
<tr>
<td>Sw Phys NEMCC</td>
<td>5</td>
<td>a</td>
</tr>
<tr>
<td>Danish Physicians</td>
<td>4</td>
<td>a &amp; c</td>
</tr>
</tbody>
</table>
Question 10) Do you consider pharmaceuticals environmental effects when prescribing them?

a) Yes
b) No. If not, what is that keeps you from doing so?

As shown in Figure 10a, five of the 24 participants do consider environmental effects of the pharmaceuticals that they prescribe.

Illustrated in Figure 10b, are the reasons why physicians do not consider environmental effects of the pharmaceuticals that they prescribe. The reason given most by the participants was the lack of knowledge, followed by priority, information, and time.
Question 11) Do you actively search for environmental information about pharmaceuticals that you prescribe?

a) Yes
b) No (if so, why not?)

As shown in Figure 11a, four of the participants said that they do actively search for environmental information on the pharmaceuticals that they prescribe. 20 of the participants answered that they do not actively search for environmental information.

![Figure 11a](image)

Figure 11a Active environmental information search on commonly prescribed pharmaceuticals.

As illustrated in Figure 11b, the three main reasons to why not are the lack of knowledge followed by the lack of time and priority.

![Figure 11b](image)

Figure 11b Reasons why physicians do not actively search for environmental information.
Question 13) Do you find the environmental information on pharmaceuticals that you prescribe to be relevant, trust worthy and useful in the practical situation?

As shown in Figure 12, ten of the participants find the available environmental information on the pharmaceuticals that they prescribe to be relevant, trust worthy and useful in the practical situation. This is if the information comes from trust worthy sources. Five of the participants answered “No” and nine said that they do not know.

Question 14) Who do you feel should be responsible for spreading environmental information about pharmaceuticals to patients? Chose one or more of the following alternatives:

- a) Physicians
- b) Pharmacists
- c) Patients
- d) Pharmaceutical companies
- e) Government/ County council
- f) Environmental authorities
- g) Other
- h) All

As illustrated in Figure 13, the option that was chosen most (16) by the participants as the body that should be responsible for spreading environmental information about pharmaceuticals to patients is authorities.
Second most (15) chosen bodies are the pharmaceutical companies (producers) and the pharmacists. Third most (14) chosen are the physicians and the government/county council. Least most (10) chosen body is the patients themselves. Other options given by six participants are the Chemical Inspection Agency, Patient Organizations, The Swedish Medical Products Agency and The Danish National Board of Health. One of the participants did not want to answer the question and therefore “Don’t know” is presented in Table 12 above. One option that was given in the question but is not presented in Table 14 is “All”. A total of seven participants found that the responsibility should be divided amongst options a-f. The order in which was chosen most was government, political, middle hand providers and consumers.

Question 15) Do you inform patients about the importance of returning un-used medications back to the pharmacy?

a) Always
b) Often
c) Sometimes
d) Never

As shown in Figure 14, half of the participants inform their patients about returning their un-used medicines back to the pharmacy sometimes. Seven of the participants inform their patients of this often. Five of the participants never inform their patients about this matter.

Question 17) The issue with antibiotic-resistant microorganisms is important for both people’s health and the environment. How do you look upon this issue and how do you handle it in your professional roll?

All 24 participants answered the same to this question, “The issue is serious, follow recommended procedure”.

![Figure 24 Informing patients to return discarded pharmaceuticals back to the pharmacy.](image-url)
The Research Questions

1) Do Swedish and Danish physicians consider environmental effects of pharmaceuticals when prescribing pharmaceuticals?

To answer if Swedish and Danish physicians consider environmental effects of pharmaceuticals when prescribing pharmaceuticals the answers of the 24 participants were examined and compared. The answers given to questionnaire question 10 were used for this comparison.

As shown in Figure 10a, five of the participants, two Danish Interns, one Sw Phys EMCC, one Sw Phys NEMCC and one Danish Physician answered yes to this question. The remainder 80 % of the participants answered no, they do not consider environmental effects of pharmaceuticals when prescribing them. The four reasons given to why they do not consider environmental effects of pharmaceuticals when prescribing them are in order, lack of knowledge, priority, information and time. See Figure 10b.

a) Is there a difference in the environmental considerations being taken by Swedish educated physicians and Danish educated physicians?

To examine if there is a difference in the environmental considerations being taken by Swedish educated physicians and Danish educated physicians results from the Sub Groups 1a, 1b, 2a, and 2c within Group 1 and Group 2 were compared. Question numbers 3, 5, 7, 9, 10, 11, 15, and 17 from the questionnaire were used for comparison, see Table 4 below.

Table 4 Results of Danish and Swedish educated physicians for comparison in research sub question d.

<table>
<thead>
<tr>
<th>QQ</th>
<th>Measuring Criteria</th>
<th>Sweden</th>
<th>Denmark</th>
<th>Difference in Favor of</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Yes</td>
<td>14/14</td>
<td>10/10</td>
<td>None</td>
</tr>
<tr>
<td>5</td>
<td>Simple reasoning</td>
<td>5/14</td>
<td>1/10</td>
<td>Sweden</td>
</tr>
<tr>
<td></td>
<td>Complex reasoning</td>
<td>9/14</td>
<td>6/10</td>
<td>Sweden</td>
</tr>
<tr>
<td>7</td>
<td>Yes</td>
<td>0/14</td>
<td>0/10</td>
<td>None</td>
</tr>
<tr>
<td>9</td>
<td>Info sources used</td>
<td>27</td>
<td>12</td>
<td>Sweden</td>
</tr>
<tr>
<td>10</td>
<td>Yes</td>
<td>2/14</td>
<td>3/10</td>
<td>Denmark</td>
</tr>
<tr>
<td>11</td>
<td>Yes</td>
<td>2/14</td>
<td>2/10</td>
<td>Denmark</td>
</tr>
<tr>
<td>15</td>
<td>Yes</td>
<td>12/14</td>
<td>7/10</td>
<td>Denmark</td>
</tr>
<tr>
<td>17</td>
<td>Serious, follow recommen-</td>
<td>14/14</td>
<td>10/10</td>
<td>None</td>
</tr>
</tbody>
</table>

The $\chi^2$–test (Appendix 2) gave a p-value of 0.826 which means that there is no significance between the two groups. Based on the answers given by the participants and the $\chi^2$–test, there is no difference between the environmental considerations being taken by physicians educated in Denmark or Sweden.

b) Is there a difference the considerations being taken between newly educated physicians and more experienced physicians?
To examine if there is a *difference in the environmental considerations being taken between newly educated physicians and more experienced physicians* the results between Group 1 and Group 2 were compared. The answers given to the questionnaire questions 3, 5, 9, 10, 11, 15, and 17 were used for comparisons see Table 3 on the next page.

**Table 3** Results of Group 1 and Group 2 for study sub question b.

<table>
<thead>
<tr>
<th>QQ</th>
<th>Measuring Criteria</th>
<th>1. MI</th>
<th>2. EP</th>
<th>Difference in Favor of</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Yes</td>
<td>10/10</td>
<td>14/14</td>
<td>None</td>
</tr>
<tr>
<td>5</td>
<td>Simple reasoning</td>
<td>3/10</td>
<td>3/14</td>
<td>Medical Interns</td>
</tr>
<tr>
<td></td>
<td>Complex reasoning</td>
<td>4/10</td>
<td>11/14</td>
<td>Experienced Physicians</td>
</tr>
<tr>
<td>9</td>
<td>Info sources used</td>
<td>10</td>
<td>35</td>
<td>Experienced Physicians</td>
</tr>
<tr>
<td>10</td>
<td>Yes</td>
<td>2/10</td>
<td>3/14</td>
<td>Experienced Physicians</td>
</tr>
<tr>
<td>11</td>
<td>Yes</td>
<td>1/10</td>
<td>3/14</td>
<td>Experienced Physicians</td>
</tr>
<tr>
<td>15</td>
<td>Yes</td>
<td>6/10</td>
<td>13/14</td>
<td>Experienced Physicians</td>
</tr>
<tr>
<td>17</td>
<td>Serious, follow recommendations</td>
<td>10/10</td>
<td>14/14</td>
<td>None</td>
</tr>
</tbody>
</table>

The $\chi^2$—test (Appendix 2) gave a p-value of 0.384 which means that there is a significance between the two groups. Based on the answers given by the participants and the $\chi^2$—test, there is a difference between the environmental considerations being taken by newly educated and more experienced physicians. The more experienced physicians seem to take more environmental considerations in their professional roll than what newly educated physicians do.

**c)** Is there a difference in the environmental considerations being taken by the physicians who are employed at an ISO 14001 certified organization and those who are employed at a public health care provider that has not implemented an environmental management system?

To examine if there is a *difference in the environmental considerations being taken by the physicians who are employed by an ISO 14001 certified organization and a public health care provider that has not implemented an environmental management system*, the results between Sub Group 2a and 2c were compared. Answers to the questionnaire questions 3, 5, 9, 10, 11, 15, and 17 were to be used for comparison.

Do to the fact that there was an uneven amount of participants attained to represent the two mini groups’, this question remains unanswered in this project. It is worth noting that no differences have been noticed. However, this study did not go into any details about if the certified clinics have identified “pharmaceuticals” as a significant environmental aspect or not.
Discussion

The Research Questions

1) **Do Swedish and Danish physicians consider environmental effects of pharmaceuticals when prescribing pharmaceuticals?**

The results of this study show that physicians are environmentally aware. They do think about the fact that the products they are prescribing do have potential negative effects on the environment. They already disseminate some information to patients about antibiotics, and to some extent, the importance of returning discarded pharmaceuticals to the pharmacy. Physicians could, with the right foundation of environmental information and support, disseminate important environmental information to patients. An important observation of the study is that physicians have difficulties to find relevant information about the environmental effects of active drug ingredients. In Sweden, FASS provides some useful information, but my impression is that the information is not fully utilized by the physicians. In Denmark this kind of information is not available.

   a) **Is there a difference in the environmental considerations being taken by Swedish educated physicians and Danish educated physicians?**

Based on the answers given by the participants, there is no difference between the environmental considerations being taken by physicians educated in Denmark or Sweden. Sweden seems to be, in general, more environmentally aware because environmental awareness is brought up in just about every sector in the country but when it came to the questions within this project, there was no real apparent difference. Both the interns and the experienced physicians representing both groups seemed to be just as environmentally aware and took the same environmental considerations. One difference that did stand out, but that is not a part of this study was that the Danish participants were more intoned with antibiotics used in pig farming. This is not so strange when one looks at publicity the subject has gotten in Denmark.

   b) **Is there a difference in the considerations being taken between newly educated physicians and more experienced physicians?**

Based on the answers given by the participants, there is a difference between the environmental considerations being taken by newly educated and more experienced physicians. The more experienced physicians seem to take more environmental considerations in their professional roll than what newly educated physicians do. This is not so strange when one thinks about the fact that the experienced physicians have had a lot more time to consider the subject. Most of them were able to paint up the whole environmental picture and most of them said that they have a personal interest in the subject. The newly educated physicians have most likely a larger interest in gaining experience within their educated field rather than seeking information in another field.

   c) **Is there a difference in the environmental considerations being taken by the physicians who are employed by an ISO 14001 certified organization and a public health care provider that has not implemented an environmental management sys-
Only four participants were attained to represent the clinics that are not ISO 14001 certified. Unfortunately this had large effect on the study, as there were five in the other comparing group. I could have randomly picked four participants representing the ISO 14001 certified clinics to make the comparisons with but that did not fall into my interest, as the Sub Groups are so small. The participants representing the clinics that are not ISO 14001 certified were all environmentally aware and seemed to be just as aware as those who represent the certified clinics. Once again, the participants said that their environmental awareness was due to their own interest. Neither sub group’s said that their employers provided much environmental information on pharmaceuticals.

The Questionnaire Questions
As mentioned in the “Method”, interview times ranged between 13 and 90 minutes. About 1/3 of the participants were quite short in their answers, and 2/3 were willing to conversation under the interview session. This could have affects on the results that have been presented in this project. Those who were willing to discussion around the questions were able to make themselves a little clearer. There is also a chance that in the interview discussions, I had more influence on the participants’ answers than what I had anticipated.

Some of the questionnaire questions were broad and thereby allowed a verity of unexpected answers. There is no real right or wrong answer either which made it difficult to be able to rate the given answers. In order to be able to compare the answers between the groups and answer if there are any differences I needed to come up with specific methods for specific questions, which are explained in “Method”.

Environmental Awareness
Questionnaire questions 2, 4, 5, and 6 brought up environmental awareness. Many of the participants seemed to be quite environmentally aware. All of them said that this had to do with their own personal interests within the subject. Most were in tuned with the political discussions that have taken place over the past decade as well as environmental actions that have taken place within local communities, their own countries, and some global actions.

Environmental Aspects
Questionnaire question 3 brought up environmental aspects. When it came to translating the answers given to questionnaire question 3 I ran into a few difficulties. First of all, I don’t think many of the participants understood the term “environmental factor”. This became apparent when most of the participants stalled when I asked them this specific question. After translating the participant’s answers, most of the factors given could be placed into one of three groups, “non-toxic environment”, “clean water” or “clean air”. Non-toxic environment should include both clean air and water but because some of the participants answered both non-toxic environment and one or more of the other factors, I chose to present the answers according to the three factors that are explained in “Method for Specific Questionnaire Questions”. There were three other environmental factors given by the participants that I found to be very difficult to place into one of the three groups. The three factors were “world population...
growth”, “clean food” and “hormones”. There is of-course a clear connection between world population growth and an increased amount of pharmaceuticals emitted into the environment but it was un-clear if the Danish Physician who answered this factor was thinking of that connection. There is also a clear connection between pharmaceuticals and food production as many crops and livestock are treated with different pharmaceuticals, mainly antibiotics. It was not clear if the two participants who answered this factor were thinking of this particular connection or not. These two factors were therefore presented as “Environmental factor”. Three of the Danish participants answered hormones as an important factor. Hormones have been highly discussed at work places and in mass media as an environmental poison that affects fish and amphibians so I translated hormones as being clean water.

One of the best answers given to this question was by a Physician employed by a Swedish clinic that is not ISO 14001 certified: “Yes the environment is fundamental, people are just a part of the whole picture. Biological diversity has a value of its own”. This particular participant has worked on raising the pharmaceutical and environmental subject for discussion on a governmental level a few years back. Unfortunately the subject was dismissed at the time.

Waste management was brought up by several of the participants through out the interviews. Many commented on the difficult procedure of returning discarded pharmaceuticals back to the pharmacies in Sweden. Another comment that was somewhat frequent was the amount of papers, plastics and packages that come with pharmaceutical products. Also the fact that many pharmaceutical products come in the wrong size, meaning that there is often an excess amount of the product compared to the producers recommended dose amount.

Another environmental aspect that was brought up in some of the participants’ answers to questionnaire question 21 was the environmental impact that is due to the production phase of pharmaceuticals. Most pharmaceuticals are produced in third world countries where environmental regulations are sparse. A participant representing an ISO 14001 certified clinic stated that “wouldn’t it be better for the environment if pharmaceuticals, especially generic kinds, were produced in countries that do have a lot of environmental regulations”.

Pharmaceuticals in the Whole Environmental Picture

Questionnaire questions 3, 5, 16, 19 and 21 brought up pharmaceuticals in the whole environmental picture. Questionnaire question 5 asked for an answer of reasoning. Once again the participants gave a verity of answers and I had to come up with a specific method for translating these as well. I came up with three classifications: “no reasoning”, “simple reasoning” and “complex reasoning” which I have described in “Method”. When a simple reasoning was given, it was not always clear if the participant was aware of the whole environmental picture or perhaps thought that I would know what they meant by simply saying “hormones” or “antibiotic resistance”. During the interview period it became clear to me that the more experienced Physicians were able to not only give a more complex reasoning around this question, they were also more confident in their answers than what the Interns were. After examining the results it was obvious that the experienced physicians gave a more complex reasoning around this question than what the Interns did.
Environmental Education

Questionnaire questions 6, 7, and 9 brought up environmental education. When I got to questionnaire question 7, all of the participants stopped me as soon as I got to “base education of medical school” during the interview and said “NO”. This is not so strange for the Experienced Physicians as environmental issues have not been so highly addressed until recent years. What I found to be surprising was that only one participant, a Danish Intern, mentioned that he has received environmental education within some of his pharmacology courses in medical school. The Swedish Interns laughed when I asked them the same question and said that they don’t even have a course within pharmacology. Some of the Swedish Interns said that the only environmental education provided within their education was by pharmaceutical companies, which is a source they have little trust in.

Access to Environmental Information

Questionnaire questions 9, 11-15, and 20 brought up environmental information. Nine of the participants’ answers to the last questionnaire question underlined the need for the right kind of environmental information so that physicians and other middle hand providers could make more environmentally sound decisions.

Although only four participants answered that they actively search for environmental information about the pharmaceuticals that they prescribe, majority of the participants said that they have searched for some information at one point or another. The reason given most frequently to why they do not search actively is because the times that they have searched has been a waste of time as there was nothing to be found. One of the Danish Physicians said, “Why search for something that isn’t there?”

Questionnaire question 9 brought on many interesting conversations. The answers to this question are practically impossible to use because although half of the participants gave one or more options nearly all of them said that there is hardly any environmental information provided at all. Nearly all of the participants said that there is some environmental information provided by the pharmaceutical companies but because the participants have little trust in the pharmaceutical industry they do not trust environmental information provided by such sources.

The most common picked source for environmental information was informative databases such as FASS.se and IRF.dk, but those (13) who had answered this as an alternative also said that there is hardly any environmental information provided within the databases. Three of the participants that I had interviewed in person took the time to show me what kind of environmental information was provided within both the Danish and Swedish databases. The participant entered some of the medicines they prescribe most and showed me that there was no environmental information at all. These databases are under development so there is hope that more useful environmental information will be accessible for the users, which also includes patients.

The second most common source for environmental information picked by 11 participants was articles in mass media. This I find to be a little alarming. The mass media is a great source of all kinds of different information but the information that they provide is not always based on truthful facts. Many of the participants did under line that it is from different medical magazines that they find such information. I’ve only had
the chance to look in a few of these myself. Once again, I would like to underline that
the information provided by such sources does not always have the facts right.

The third most given options given by six participants were informative papers and
none. Information papers could come from any source. Most of the participants under
lined once again that the producers do release such information but the participants
tend not to trust information coming from such sources. The alternative “None” was
not a given alternative in the questionnaire. It actually came up as an alternative al-
ready during the first interview when an Experienced Danish Physician said that she
has never received any environmental information about pharmaceuticals, other than
that provided on antibiotics. I believe that majority of the participants guessed where
the information comes from or gave an answer of where they think it should come
from rather than answered that they haven’t received any information.

One Experienced Physician employed at an un-certified clinic in Sweden said that he
searches through academicals rapports for environmental information.

One difference that really stands out in the given answers is that 4/5 employed at an
environmentally certified clinic were the only ones who said that courses that take up
the subject of pharmaceuticals and the environment are provided. None of the other
participants said that they have been offered any education within the subject through
their employer. Although one Danish Intern did say that he had taken some courses
within the subject while taking his degree.

Environmental Considerations of the Prescribed Pharmaceuticals

Questionnaire questions 3, 5, 10, 15, 16, and 17 brought up the topic of environmental
considerations. Majority of the participants answered that they do not consider envi-
ronmental effects of the pharmaceuticals they prescribe. The most common reason
given to why not was the lack of knowledge on the subject. One of the Experienced
Physicians employed at a clinic that is not ISO 14001 certified came with a great
question himself, “What am I supposed to inform my patients, that they should pee in
a bucket? And what are they supposed to do with the bucket? Stand in line at the
pharmacy and explain what the contents of the bucket might be?” This I find to be a
great question.

One way to address this would be to include some environmental education within
medical school and at the clinics. I find it to be quite strange that the middle hand
providers of potentially environmentally harmful substances not only lack a full on
pharmacology course but also lack guidance within the environmental area of their
profession. Several of the experienced participants said they believe that the very best
way to address the pharmaceutical problem would be to restrict medical prescriptions
and prescribe life-style changes instead, or as one participant from an un-certified
clinic said “We are not trained to prescribe lifestyle change as a solution to health
problems, we are trained to prescribe medicines that will help ease the problem.”
Perhaps it is time to take another look and re-valueate how and why we use a lot of our
pharmaceutical products today.

Environmental Responsibility and Communication

Questionnaire questions 11-15, 17, and 20 brought up environmental communication.
Questionnaire question 14 is difficult to use to answer any of the four study questions
but it is definitely interesting to look at. Seven options were provided in the question. What was interesting to find out was who the physicians find should be responsible for communicating environmental information about pharmaceuticals to patients. If they found that the responsibility should fall on more than one, then it was also interesting to know in which order the responsibility should be. All seven of the participants who had answered “all” said that the responsibility chain should be so that the producer should provide all the necessary product information to the government. With help from the governments different authorities (chemical, environmental protection, health care, medical agencies) they should check the information provided by the producer and after all requirements pass through, the agencies should translate the information and send it down stream to states, communities, physicians, dentists and pharmacists. All of the down stream catchers should pass the information on to the patients. From what I have researched, this is approximately the way it is intended to work today.

Five of the participants answered that responsibility should fall on the physician first but this is only if the physician has the right foundation which should be provided by manufacturers and authorities. Pharmacists also have a middle roll function in the distribution chain of pharmaceuticals. Only one of the participants found that the first hand responsibility should be on the pharmacist. It would be interesting to find out what the pharmacists would answer to this question. Patients play an important roll in the whole pharmaceutical chain. They are not only a target group but also those who actually are the emitters of pharmaceuticals and metabolites into the environment. Several of the participants found that the patients should be responsible for looking up information about pharmaceuticals but had very little confidence in this ever happening. One of the Danish Interns answered that the responsibility should be on the patient in the first hand.

As the manufacturers and the distributers, the producers of pharmaceuticals play an accentual roll in pharmaceuticals presence in our environment. Three of the participants found that the main responsibility should be on the producers. Unfortunately none of the participants seemed to have any trust in the pharmaceutical companies when it comes to them providing trustworthy information. Many of the Experienced Physicians had a lot of negative thoughts to express about this particular group and something that came up frequently was “they are known for releasing information that is colored, angled or even a straight up a lie, in their own advantage”. This is yet another topic that would be interesting to research deeper.

The government and city council play an important roll in the matter, as they are the ones who regulate products as well as the ones who are responsible for our wastewater treatment facilities. One participant, an Experienced Physician employed in Denmark found that the head responsibility should fall within this group. Environmental authorities play an important roll in providing guidelines and regulating toxins in our environment. Three participants found that the head responsibility should fall on Environmental authorities.

Other options given by six of the participants were, The Chemicals Inspection Agency, Patient Organizations, The Swedish Medical Products Agency and The Danish National Board of Health.
Although it is not regulated that the physicians should inform their patients about returning discarded medicines back to the pharmacy, I find it strange that they are not recommended to do so. As the middle hand provider and often most trusted by the patients, the physicians could have a positive influence on the matter. Majority of the Experienced Swedish Physicians had a little more to say about this topic. “Why would I inform my patients that not only do they have to stand in line to get their medicines, they also have to stand in line and get interrogated about what it is they are returning, and that I am supposed to do in the few minutes that I actually speak to the patient about their health problem?” This is a good question but then again this is a statement about the pharmacy’s (and government’s) dysfunctional procedure of returning discarded pharmaceuticals back to the pharmacy. Another subject that came up along with this question is that pharmaceuticals are well packaged and there is a lot of excess paper that comes from the producers. Of course it is important that pharmaceuticals come well packaged but according to a few of the participants, most of the medicines could come in less packing which of course would have less impact on the environment. Quite a few of the participants also commented on the amount of papers, in form of commercials (and packaging) that come from the pharmaceutical companies.

**Antibiotic Resistance**

Questionnaire question 17 brought up this topic. Antibiotic resistance is a serious and highly discussed issue in many countries across the world today. After conducting the interviews there was no doubt that all of the participants were well informed about this particular issue. Many of the participants started talking about it already in the start of the interview. It is a very good sign that the participants could inform so much on the matter because this particular issue has put demand on several bodies including government, environmental and health authorities, producers and physicians. The information has gone all of the way through the responsibility chain. This not only shows that the communication chain has worked, change is possible if the right information goes to the right people.

I have not been able to find any official standard prescribing recommendations for antibiotics but considering that all of the participants answered the same procedure, I figure that there must be some kind of standard procedure that they have been recommended to follow. One of the last steps in this procedure is to inform the patient of the matter. This I would like to highlight, as it is my main concern within this project- communicating to patients that the product they have gotten prescribed can have a negative effect on the environment.

**Future research**

Many interesting topics within the subject of pharmaceuticals and the environment have been taken up in this study but the research questions cannot be considered completely answered. To be able to give more righteous answers, I feel that I would need to ask at least 20 individuals representing each sub group. The questionnaire questions would need to be more direct and the possible answers easier to rate and thereby compare. Never the less, this pilot study does give good base for future studies and research within the area. It would be interesting to ask other subject groups such as government, pharmacist, patients and producers similar questions to see where their stand-point within the subject lays.
Conclusion
Pharmaceuticals are chemicals. Chemicals can have negative environmental effects. Physicians do consider the fact that the products they are prescribing do have potential negative effects on the environment. They already disseminate information about antibiotics and, to some extent, the importance of returning discarded pharmaceuticals to the pharmacy. As the middle hand provider and the third to last individual within the distribution chain of pharmaceuticals, physicians have the possibility to make a positive environmental difference.

The participants of this study claimed that there are other ways to address the environmental pharmaceutical dilemma, which requires more demand on all of the representatives within the distribution chain of pharmaceuticals. With the right foundation, physicians are able to make more environmentally aware choices when it comes to prescribing pharmaceuticals. Physicians could, with the right foundation of environmental information, disseminate important environmental information about the prescribed products to patients. Every little bit of environmental responsibility taken by all of the representatives in the distribution chain of pharmaceuticals can make a positive difference in the whole environmental picture.

Further Recommendations
As mentioned throughout this project, the medical education provided in both Denmark and Sweden today includes very little environmental education and awareness. Environmental education should therefore be included in medical education. It is important that the “middle hand providers” of potentially environmentally harmful substances understands and can disseminate that the products they are prescribing do have environmental effects. Another subject that was brought up during the interview period by several of the participants was that physicians are trained to prescribe pharmaceuticals rather than life-style changes. From both an environmental and a health point of view, a life style change would have larger benefits in the whole picture than what chemicals have. This should be addressed as soon as possible.

More environmental demand should be put on the pharmaceutical producers. As of today, the environmental demand is only found within the clinical stages of drug approval. There is little environmental demand on the producers after that of which the product is released onto the market. The producers should have to take more environmental action especially when it comes to the cleanup of environmental effects caused by their products after consumption. The economical costs of environmental damage caused by the presence of pharmaceuticals in the environment should fall on the producers. As mentioned before producers are to perform environmental risk assessments today but the risk assessments could also use some development. Synergic effects as an example are as of today not mandatory in the risk assessments.

Environmental communication should be strengthened throughout the distribution chain of pharmaceuticals. This is highly important especially when it comes to informing the consumer (patient) of the product.
Acknowledgements
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References

Aarhus University
Referred to as Dk Unv 1 2011 in the text

American Environmental Protection Agency, 2010
[http://epa.gov/ppcp/]
Collected 2011-01-28, Page updated 2010-10-28
Referred as AEPA, 2010 in the text

American Environmental Protection Agency, 2011
[http://www.epa.gov/ppcp/faq.html#quantities]
Collected 2011-05-22, Page updated 2010-10-28
Referred to as AEPA 2011 in the text

7.2 American Food and Drug Administration, 2010
Collected 2011-05-19, Page updated 2001-09-25
Referred as FDA 2001 in the text

Andrews, D. Chu, S. Hongxia L. Judt, C. METCALFE, C. Oakes, K. Servos, M.,
2009, ANTIDEPRESSANTS AND THEIR METABOLITES IN MUNICIPAL
WASTEWATER, AND DOWNSTREAM EXPOSURE IN AN URBAN WATERSHED
Environmental Toxicology and Chemistry, Vol. 29, No. 1, pp. 79–89, 2010
Referred to as Andrews, D. 2009 in the text

ISBN: 91-85574-54-6
Referred to as Apoteket AB 2005 in the text

Apoteket AB, MistraPharma, Stockholms läns landsting, 2009 En frisk framtid 2009
ISBN: 2182-01
Referred to as Apoteket AB 2009 in the text

The appropriateness of prescribing antibiotics in primary health care in Europé with
respect to antibiotic resistance, 2010 (APRES)
[http://www.nivel.eu/apres/]
Collected 2011-05-01, Page updated 2009-11-16
Referred as APRES 2009 in the text

Bagnati R. Calamari, D. Castiglioni, S. Chiabrando, C. Fanelli R. Pomati, F. Reitano,
G. Rossetti, C. Zuccato, E. 2006, Pharmaceuticals in the Environment in Italy: Caus-
Referred as Bagnati, R. 2006 in the text

Brosché, S. 2010, *Effects of pharmaceuticals on natural microbial communities: Tolerance development, mixture toxicity and synergistic interactions*  
Referred to as Brosché, S. 2010 in the text

Referred to as Fick, R. 2008 in the text

The Danish Environmental Protection Agency  
[http://www.mst.dk/English/Focus_areas/]  
Collected 2011-05-05, Page updated 2009-12-21  
Referred as DEPA 2009 in the text

The Danish Medicines Agency  
[http://laegemiddelstyrelsen.dk/en]  
Referred as DMA 2011 in the text

Referred to as Daughton, T 1999 in the text

European Commission, REACH  
[http://ec.europa.eu/environment/chemicals/reach/reach_intro.htm]  
Collected 2011-05-01, Page updated 2011-03-01  
Referred as REACH 2011 in the text

The European Environment, 2010, *Increasing environmental pollution load - Assessment of global megatrends, State and Outlook, 2010*  
Referred as European Environment 2010 in the text

The European Environment, 2010, *Increasing environmental pollution load - Assessment of global megatrends, State and Outlook, 2010a*  
Referred as European Environment 2010a in the text

European Medicines Agency, 1995-2011  
Collected 2011-05-20, Page updated 2011  
Referred as EMA 2010 in the text

Referred to as Fick, R. 2008 in the text

Referred to as Heberer, T. 2002 in the text

International Organization for Standardization
[http://www.iso.org/iso/iso_14000_essentials]
Collected 2011-05-11, Page updated 2011
Referred to as ISO 2011 in the text

IPEC Federation, 2010
[http://www.ipecfed.org/]
Collected 2011-05-22, Page updated 2010
Referred to as IPEC 2010 in the text

Karolinska Institutet
[http://ki.se/ki/jsp/polopoly.jsp?d=133&l=en]
Referred to as Sw Unv 2 2011 in the text

Knaggård, Å. *Att hantera vetenskaplig osäkerhet i klimatpolitiken* 2010, Seminarium med Lunds Filosoficirkel
Attended 2010-03-30
[http://video.ldc.lu.se/fc10h1.htm]
Referred to as Knaggård, Å. 2010 in the text

Referred to as Kümmerer, K. 2001 in the text

[http://books.google.com/books?id=A3GQsHZCmdsC&lpg=PP1&ots=Irthl6OSTz&dq=Pharmaceuticals%20in%20the%20Environment%20Sources%20Fate%20Effects%20Risks&pg=PA4#v=onepage&q&f=true]
Referred to as Kümmerer, K. 2004 in the text

Referred to as Kümmer, K. 2009 in the text

Linköping University
[http://www.liu.se/?l=en]
Collected 2011-05-17, Page updated 2011-05-17
Referred to as Sw Unv 3 2011 in the text

Lund University
[http://www.med.lu.se/english/about_the_faculty]
Collected 2011-05-13, Page updated 2010-12-29
Referred to as Sw Unv 4 2011 in the text

MedicineNet.com 2006-2011
Collected 2011-05-20, Page review 1998-03-26
Referred as MN 2011 in the text

Medical Dictionary, 2007
Collected 2011-05-19, Page updated 2011
Referred as MD 2007 in the text

Medical Dictionary, 2009
[http://medical-dictionary.thefreedictionary.com/Prescription+drugs]
Collected 2011-05-04, Page updated 2011
Referred to as MD 2009 in the text

Medical Dictionary, 2011
Collected 2011-05-20, Page 2011
Referred as MD 2011a in the text

Medical Dictionary, 2011
Collected 2011-05-20, Page updated 2011
Referred as MD 2011b in the text

Medical Dictionary, 2011
Collected 2011-05-20, Page updated 2011
Referred as MD 2011c in the text
The research-based pharmaceutical industry, LIF
[http://www.lif.se/cs/default.asp?id=43139]
Collected 2011-05-05, Page updated 2011-05-06
Referred as FASS 2011 in the text

Referred as Roig, B. 2010 in the text

Referred to as Santos, L. 2009 in the text

The Swedish Association of the Pharmaceutical Industry AB
The Research-based Pharmaceutical Industry in Sweden, LIF, 2008, *Svenska miljöklassificering av läkemedel*
Referred to as LIF 2008 in the text

The Swedish Environmental Code, Miljöbalken, 1998
[http://www.regeringen.se/content/1/c4/13/48/385ef12a.pdf]
Referred as SEC 1998 in the text

Swedish Environmental Objectives, 2011
[http://www.miljomal.se/Environmental-Objectives-Portal/]
Collected 2011-05-01, Page updated 2009-11-16
Referred as SEO 2011 in the text

The Swedish Medicines Information Portal on the Internet, FASS, LIF, 2004
[www.fass.se]
Collected 2011-05-05, Page updated 2011-05-05
Referred as FASS 2004 in the text

The Swedish Medicinal Agency, Läkemedelsverket, 1990
[http://www.lakemedelsverket.se/malgrupp/Allmanhet/Lakemedel/Vad-ar-ett-lakemedel/]
Collected 2011-05-19, Page updated 2006-10-02
Referred as SMA 2006 in the text

Syddansk University
[http://www.sdu.dk/Uddannelse/Bachelor/Medicin]
Appendix 1

Questionnaire

General Questions

1) Which year and from which university did you receive your medical degree?

2) Do you find yourself to be more or less environmentally aware in your private life now than what you were ten years ago? What’s the reason of change?
   a) More environmentally aware
   b) Less environmentally aware
   c) Unchanged environmental awareness

3) Do you find the environment to be an important factor for people’s health? If you do, which environmental factors do you feel are of most importance?

4) Do you find yourself to be more or less environmentally aware in your professional roll today than what you were ten years ago? What’s the reason of change?

Pharmaceuticals and the Environment

5) How do you reason when I ask you to think about the connections between the use of pharmaceuticals and environmental effects?

6) Do you feel that you have enough information/knowledge in your professional roll, when it comes to understanding the interaction between pharmaceuticals, environment and health?
   a. Yes
   b. No

7) Do you feel that you have received enough knowledge about pharmaceuticals and their environmental effects during your base education of medical school to be able to:
   a. Understand the connections between usage of pharmaceuticals and their effects on the environment?
   b. Look up environmental information about pharmaceuticals?
   c. Inform patients about potential environmental effects of pharmaceuticals?

8) Do you feel that after your education have gotten enough support from your employer (education, information, time, etc.) to develop your knowledge of pharmaceuticals environmental effects?
9) How do you get environmental information about pharmaceuticals? Chose one or more of the alternatives below.
   a) Informative databases: FASS (Patient FASS)/ medicin.dk / "Kloka listan" (SLL:s informationsmaterial)
   b) Education/course
   c) Information papers
   d) Information meetings
   e) Articles in mass media
   f) Discussions with colleges

10) Do you consider pharmaceuticals environmental effects when prescribing them? If not, what is that keeps you from doing so?

11) Do you actively search for environmental information about pharmaceuticals that you prescribe?
   a. Yes
   b. No (if so, why not?)

12) Who/Which stand for the environmental information provided on pharmaceuticals?
   a) The Food and Drug Administration
   b) Government
   c) Pharmaceutical companies (producers)
   d) Other, if so then who?
   e) Don’t know

13) Do you find the environmental information on pharmaceuticals that you prescribe to be relevant, trust worthy and useful in the practical situation?

14) Who do you feel should be responsible for spreading environmental information about pharmaceuticals to patients? Chose one or more of the alternatives below.
   a. Physician
   b. Pharmacist
   c. Patient
   d. Pharmaceutical companies
   e. Government/ County council
   f. Environmental authorities
   g. Other
   h. All

Waste, start dosage, ect.

15) Do you inform patients about the importance of returning un-used medication back to the pharmacy?
   a) Always
   b) Often
   c) Sometimes
   d) Never

16) Do you take the advantage to prescribe start dosages of medication (e.g. to avoid waste and environmental effects)?
a) Yes  
b) Sometimes  
c) No, why not?

17) The issue with antibiotic-resistant microorganisms is important for both people’s health and the environment. How do you look upon this issue and how do you handle it in your professional roll?

18) How often do you prescribe medication per patient visit?  
a) Not often (< 33 %)  
b) Pretty often (33 – 66 %)  
c) Often (> 66 %)

19) Do you think that the "Free-card-system" leads to hoarding and excess cassation of pharmaceuticals?

20) Do you believe that the generic exchange system adds to excess cassation of pharmaceuticals?

21) Is there anything else you would like to add about the connection between the usage of pharmaceuticals and environmental effects?
## Appendix 2

### CHI2-test

#### Table A1. CHI2-test between Denmark and Sweden

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#### Table A2. CHI2-test between Medical Interns and Experienced Physicians

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Footnotes

1 European Environment 2010
2 European Environment 2010a
3 Bagnati, R. 2006
4 AEPA, 2010
5 Kümmer, K. 2008
vi Kümmer, K. 2009
vii Santos, L. 2009
viii Daughton, T 1999
6 WHO, 2010
7 Roig, B. 2010
xi SMA 2006
xii FDA 2001
xiii MD 2007
xiv IPEC 2010
xv MD 2009
xvi LIF 2008
xvii Bagnati, R. 2006
xviii Broschê, S. 2010
xix Andrews, D. 2009
xx Apoteket AB 2009
xd Heberer, T. 2002
xxi Kümmerer, K. 2001
xxii Kümmerer, K. 2004
xxiv Kümmerer, K. 2008
xxv Fick, R. 2008
Fick, R. 2008
AEPA 2011
Apoteket AB 2005
CPMP/ICH/291/95
MD 2011a
MD 2011b
MD 2011c
MN 2011
CPMP/ICH/291/95
REACH 2011
EMA 2010
Apoteket AB 2005
APRES 2009
SEC 1998
SMA 2006
SEO 2011
FASS 2004
FASS 2011
DEPA 2009
DMA 2011
Knaggård, Ä. 2010
Sw Unv 1 2011
Sw Unv 2 2011
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