The perceived development needs for medicines information services in university hospital pharmacies: A mixed methods study

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A B S T R A C T

Background: Reliable and evidence-based medicines information (MI) is critical for patient care. To guarantee this, in many countries, there are medicines information centers (MICs) which offer medicines information services (MISs). While there are no MICs in Finland, pharmacists in all five university hospital pharmacies provide MISs. A proposal for establishing five MICs has been made by the National Medicines Information Network.

Objectives: The aim was to explore the current MISs and the perceptions of current and potential MI service providers of the need for the proposed national MICs. Barriers and facilitators for potential transition from the current MISs provided by the university hospital pharmacies to establishing national MICs, were examined.

Methods: This sequential explanatory mixed methods study was conducted nationally during September 2019–April 2020 as an online survey and semi-structured individual, pair and group theme interviews with hospital representatives. The survey questionnaire was sent to chief pharmacists and MI pharmacists in all five Finnish university hospital pharmacies ($n = 5$, census). The interviews ($n = 13$) were carried out with chief pharmacists, MI pharmacists, medication safety officers (pharmacists), chairs of the Medicines Advisory Board (physicians) and clinical pharmacologists (physicians) (participants $n = 19$). The data was analyzed using descriptive quantitative analysis and qualitative content analysis.

Results: All invited representatives participated in the study. Offered MISs are quite similar but the human resources vary among the organizations. Answering MI questions was one of the core MISs. Most representatives considered a proposal of establishing five MICs to Finland positively. The expected benefits were related to achieving an official status to enhance MI, establishing the MICs within the university hospitals and close to where the MISs are needed, and fostering multiprofessional collaboration and collaboration between the MICs. Limited financial and human resources were seen the most critical challenges.

Conclusion: The existing expertise of the pharmacists and the similarities in MISs provided by the university hospital pharmacies seem to provide a good basis and preconditions for expanding MI operations and forming MICs at the national level. By pooling current limited resources, synergies could be achieved and MISs, and potentially MICs developed. The establishment of MICs may enhance utilization of networking and multiprofessional collaboration in producing MISs at the national level.

1. Introduction

Pharmacists have a professional responsibility to provide reliable and evidence-based medicines information (MI) in healthcare.[1] Medicines Information Services (MISs) provided by MI pharmacists are valuable as many other healthcare professionals such as physicians, dentists, nurses and other pharmacists have limited time and skills to search for necessary MI.[2] The World Health Organization (WHO) has stated that medicines or drug information centers (MICs) as independent and reliable MI producers are critical for promoting the rational use of medicines[3] of value to healthcare professionals.[2] MICs are public or independently funded centers which provides information on medicines to healthcare professionals and consumers for promoting safe, effective and efficient use of medicines.[4]

One of the most important tasks of MICs is to provide a question-answer service to healthcare professionals[5,6]; some MICs also provide a service to the general public.[6] The services MICs provide and the number of questions they receive vary.[7] Some studies show that even though the MICs might answer fewer questions than a decade or half a decade earlier, answering

them has been significantly more time consuming due to more complex issues.[8,9] Increasing polypharmacy is a risk factor due to e.g. adverse drug reactions (ADRs) and drug-drug interactions, which are among the commonly asked questions, and whose occurrence MI is in a key role to prevent.[5,7,10,11] The role of MI specialists has expanded and they have begun to share their expertise and services in other areas such as medication safety and medication policy.[12] They are also often involved in educating students in various field of healthcare.[8]

The first MIC was opened at the University of Kentucky in the United States (US) and, since the 1960s, MISs have been offered in MICs, typically located in hospitals, clinics or colleges or schools of pharmacy.[13,14] Since the 1990s, the number of MICs in the US has been decreasing and the services provided have changed: some MICs have expanded their services to provide e.g. support to the pharmacy and therapeutics committee or MI and literature evaluation courses.[7,8,12] The decrease in the number of MICs may be partially due to easier access to MI through the Internet and versatile databases that have increased the availability of MI for all healthcare professionals.

Since the 1970s, many MICs have offered their services in Europe.[15] In the United Kingdom (UK), the first MIC was established in the 1970s[16] and MI is provided as a National Health Service (NHS) funded pharmacy service.[17,18] In the UK, in total, 220 local, 14 regional and one national (Wales) MICs form a network for providing a free question-answer service for healthcare professionals. Moreover, MICs offer their support e.g. in medicines management and patient safety issues by participating in various committees and groups. In the UK, questions and answers about medicines are published in an Internet-database.[19]

Similar to the US and the UK, the Nordic countries Sweden, Norway and Denmark have MICs.[20,21] In Sweden, there are now seven regional MICs, the first hospital-based MIC was established in 1974.[11,21,22] In Norway, a national network of four regional medicines information and pharmacovigilance centers in regional university hospitals was established in 1995,[20,23] while in Denmark, there are five regional clinical pharmacology centers.[24] The pharmacists and clinical pharmacologists in these Nordic MICs answer questions from healthcare professionals, and some of MICs publish the questions and answers in public or internal databases.[11,20–24]

In Finland, another Nordic country, there are some MI providers whose activities most resemble the work of MICs. Since the 1960s the Poison Information Center has responded to questions concerning the prevention and treatment of acute poisonings, and in 1994 the Teratology Information Service was established to answer questions about pregnancy and lactation.[25–28] These both services on specific issues are provided by the Helsinki University Hospital District, but their services are nationwide, *free of charge*, and available both to healthcare professionals and the general public. The Pharmaceutical Information Centre offers a *fee-for-service* MI to healthcare professionals on non-acute MI questions.[29] However, little is known about the MISs provided by pharmacists in all university hospital districts.

In 2011, the Ministry of Social Affairs and Health published a national Medicines Policy 2020 which emphasized the rational use of medicines and provision of reliable and evidence-based MI in Finland.[30] In 2012, the first national MI strategy was published and the National Medicines Information Network, which operates under the Finnish Medicines Agency (Fimea), was formed.[31,32] Fimea and the Medicines Information Network promote the MI strategy and its strategic goals and strengthen the coordination of MI provision and development nationally. National Medicines Information Network has proposed the establishment of five MICs. Establishing national MICs could contribute to the objectives of the MI strategy by strengthening the MISs currently provided. To inform this national discussion, it is crucial to study the conditions for these new activities by examining the current situation of MISs and the perceived opportunities and challenges for the operation of national MICs. As the authors are involved in the National Medicines Information Network, they all have an interest in the topic and the study opens the perspective of potentially developing MISs at university hospital pharmacies, locally and nationally.

Firstly, the aim was to explore the perceptions of pharmacists responsible for (i.e. chief pharmacists and MI pharmacists if any) MISs and their

development of the current status of MISs provided by pharmacists in the five Finnish university hospitals, i.e. in tertiary care, through a survey. Secondly, in the same university hospitals, through interviews, the aim was to explore the perceptions of chief pharmacists, MI pharmacists, medication safety officers (pharmacists), chairs of the Medicines Advisory Board (physicians), and those clinical pharmacologists (physicians) who provide a consultation service, of the need for establishing national MICs. Thirdly, by combining the survey and interview methods, barriers and facilitators of a potential transition from the current MISs provided in the university hospital pharmacies to the forming of national MICs were explored.

2. Material and methods

2.1. Context of the study

In Finland, a country of 5.5 million people, municipalities are responsible for organizing public healthcare services.[33,34] Private healthcare services are complementary to publicly funded services, and cover more than a quarter of all healthcare services in Finland.[34] Primary healthcare services are provided at municipal health centers, while secondary and tertiary healthcare services are provided in municipal, central or university hospitals. For organizing secondary and tertiary healthcare services, the municipalities have formed 21 hospital districts.

In turn, each hospital district belongs to one of the five tertiary care catchment areas of the university hospitals. In total, there are 25 hospital pharmacies, of which five operate in the university hospitals. Smaller medicine dispensaries operate in hospitals, health centers and private hospitals.

Tertiary care is centralized in the five university hospitals where a small group of MI pharmacists in university hospital pharmacies provide varied MISs to other healthcare professionals in their own service area. At the national level, clinical pharmacologists offer consultation services for healthcare professionals on patient specific MI questions, but the resources for this work are relatively low. Indeed, in 2019, there were only 38 physicians holding a specialization in clinical pharmacology and pharmacotherapy,[35] and a total of 14 clinical pharmacologists or specializing physicians in clinical pharmacology offered consultation services in departments of clinical pharmacology in 2021 (Backman J., Tornio A., personal communication 2021).

The Finnish government is implementing a major social and healthcare reform, in which the aim is to transfer the responsibility for organizing social and healthcare services from the municipalities to larger regions. As part of the reform, access to MI should be improved to enhance patient and medication safety.[36] The National Medicines Information Network has proposed to establish five MICs in the university hospitals, which could provide a means of improving the access to MI and resource allocation. The proposal includes, centers that would collaborate and share a joint database for medicine-related questions and answers. Pharmacists and clinical pharmacologists would work multi-professionally to provide MI and consultation services for healthcare professionals. According to the proposal, the operation of the MICs could be based on the existing resources of the university hospital pharmacies and the departments of clinical pharmacology.

2.2. Study design

This prospective sequential explanatory mixed methods study included two parts: a cross sectional survey; and semi-structured theme interviews. In the first part, the current MISs at the Finnish university hospital pharmacies were explored by using an online survey. In the second part, the need for establishing national MICs was explored through interviews with chief pharmacists, MI pharmacists, medication safety officers (pharmacists), chairs of the Medicines Advisory Board (physicians), and those clinical pharmacologists (physicians) who provided a consultation service. The mixed methods design was used to reach diverse views of the barriers

and facilitators for the potential transition from the current MISs provided in the university hospital pharmacies to forming national MICs.

According to the guidelines of the Regional Ethics Committee, an ethics committee approval was not required because no patient data were collected.[37] The research permission was obtained from the researcher's work organization (18.10.2018). Participation in the study was voluntary and confidential.

2.3. Participants

2.3.1. Survey

All university hospital pharmacies and university hospitals in Finland ($n = 5$), a census, were included in the study. The chief pharmacists, and MI pharmacists (if appointed), were contacted by an email and asked to participate in the online survey. These participants were responsible for developing the MI services and deemed to have the best knowledge of the research topic. The sample of the survey study was not individual pharmacists, but hospital pharmacies. The cover letter of the email was used to inform the participants about the survey (the objective, participants, voluntary participation, rights of participants, informed consent, data collection, confidential data analysis and anonymous data reporting, and storage and disposal of the research material) and that they could comment on the analysis of the collected data in terms of risk for identification. The participants could receive further information about the study from the researcher if requested.

2.3.2. Interview

In addition, all five chief pharmacists, MI pharmacists (if appointed), all two medication safety officers (pharmacists), all five chairs of the Medicines Advisory Board (physicians) and two clinical pharmacologists from the two existing units of clinical pharmacology, also a census, were invited to participate in the interviews. As before, these participants were deemed to have the best knowledge of the research topic. As in the survey, an email invitation was sent with all necessary information about the interviews. Before the interviews, the interviewees signed an informed consent form in which they agreed to participate and consented to the audio-recording of the interview. Additionally, at the beginning of interviews, the participants consented verbally to the audio-recording.

2.4. Development of the questionnaire and interview guide

The questionnaire and the interview guide were developed by the researchers based on the national and international scientific and professional literature on medicines information, clinical pharmacy services[13,38,39] and the research group's own practical experience of, and expertise in, MISs. The representatives of the National Medicines Information Network and the Ministry of Social Affairs and Health were given the opportunity to comment the questionnaire and the interview guide, however, only minor changes were suggested and made to the questionnaire regarding the question of the pharmacists' collaboration with clinical pharmacologists. The questionnaire is available from the authors upon request.

2.4.1. Survey

The final online questionnaire (E-form survey application, University of Helsinki) included 38 questions and was divided into three parts: 1) background information on the respondent's healthcare organization; 2) MI sources, MI requests and used information channels; and 3) developing MISs in the future. The survey included nine open-ended questions, 28 structured multiple-choice questions and one four-point Likert scale -question (4 = ´very important´, 3 = ´important´, 2 = ´quite important´, 1 = ´not important´) with additional options ´I don't know´ and ´I haven't used´. The questions were pilot tested for face validity, understandability and readability by one MI pharmacist working in one of the university hospital pharmacies, leading to some minor modifications and some removals of the questions. The pilot was not part of the final sample, however, the

pharmacist who participated in the pilot, could also participate in the final survey as the population of the potential respondents was so small.

2.4.2. Interview

A semi-structured interview guide was employed in the theme interviews. The findings of the survey were utilized to finalize the interview guide, which consisted of three themes: 1) the perceived role of the hospital pharmacies as MI producers; 2) a proposal to establish the five national MICs offering their services at a national level, and any perceived opportunities or challenges for the operation of the MICs; 3) the perceived need for national coordination of, and guidance to, the MICs. A definition of MI,[30] examples of current MISs provided by the university hospital pharmacies, examples of current services provided by MICs internationally and the proposal of the National Medicines Information Network to establish the MICs were introduced to the participants during the interviews. The first interview served as a pilot and was used to ensure that the interview guide was functional and that the questions were understandable, and to test the interview technique. The pilot interview was included in the study because no need for any changes of interview guide emerged based on the pilot. The main researcher (KU), familiar with the interview method, conducted the interviews.

2.5. Data collection and storage

2.5.1. Survey and interviews

The link to the online survey was sent to the potential participants in September 2019; only one response from each university hospital pharmacy was requested. One email reminder was sent to all participants after two weeks and at the same time the response time was extended by another two weeks.

After the collected survey data had been analyzed, the interviews were conducted between December 2019 and April 2020. The interviews were conducted as individual, pair or group interviews depending on the number of the participants. While ten interviews were conducted at the participants´ workplaces face-to-face, three interviews were completed on Skype for Business (2016) due to the COVID-19 pandemic. The interviews lasted for 40 to 70 min and all interviews were audio-recorded.

The collected data were stored in an external hard drive and stored in a locked cupboard. The data will be destroyed after the publication of the article. Only the main researcher (KU) had access to the data.

2.6. Data analysis

2.6.1. Survey and interviews

The answers for the structured questions of the survey were analyzed in Microsoft Excel® (2016) spreadsheets using descriptive statistics. Responses to the open-ended questions were analyzed qualitatively using inductive content analysis[40,41]: e.g. development of MISs during the previous two years.

The audio-recorded interviews were transcribed verbatim in Microsoft Word® (2016) software. A word or sentences were selected for a unit of inductive analysis.[40,41] From the interview data, key words or sentences were identified and extracted according to the themes of the interview guide. Key content were organized, grouped into categories and sub-categories and abstracted: e.g. identified opportunities of the proposed network model of the five MICs (Table 4.). Previous knowledge of MISs in international MICs and the proposal of the National Medicines Information Network of establishing five MICs was used as the basis for the deductive content analysis. Expressions of positive or negative attitudes towards the National Medicines Information Network's proposal and content of the proposal were identified in the interview data. The responses of the interviewees with different professional backgrounds were compared and contrasted. The analyses were conducted manually by one researcher and the coding and the interpretations were discussed with the research group for verification. All research data were analyzed confidentially and reported anonymously.

3. Results

3.1. Study participants

The representatives (i.e. chief pharmacists and/or MI pharmacists) of all five university hospital pharmacies responded to the survey, yielding one survey response per university hospital pharmacy ($n = 5$). They also participated in the interviews, as well as all two medication safety officers (pharmacists), all five chairs of the Medicines Advisory Boards of the university hospitals and the two clinical pharmacologists of departments of clinical pharmacology. In total, 13 interviews (19 participants) were conducted as individual ($n = 10$), pair ($n = 2$) and group interviews ($n = 1$). Altogether, three individual, two pair and one group interviews were conducted with pharmacists working in the university hospital pharmacies, five individual interviews with the chairs of the Medicines Advisory Boards and two individual interviews with the clinical pharmacologists.

3.2. Survey

3.2.1. Current medicines information resources

The workforce available for, and responsibilities of, MISs were variable and diverse between the university hospital pharmacies. Only one organization reported having three MI pharmacists; two of them part-time. In two others, one or more pharmacists had the main responsibility for MISs and, in the last two, no specific MI pharmacist had been appointed. However, in all five organizations MI was reported to be one part of daily work of many pharmacists. Clinical pharmacists had also a key role in providing MI to healthcare professionals on the wards. All respondents perceived that the number of people working with MI was not sufficient. Most respondents would have wanted to employ one or two full-time MI pharmacists among other things to coordinate MISs and to standardize the MI provided.

In two organizations, the current access to MI resources was considered insufficient: e.g. further access to up-to-date literature was required. In all five organizations, there was a need for providing more training in MI searching skills especially for junior pharmacists and those working on the wards.

3.2.2. Current medicines information services

Answering MI questions was one of the core MISs in all university hospitals (Table 1). The respondents perceived different services to be the four most important MISs produced their own organization: answering MI questions ($n = 5$); producing medicine-related instructions ($n = 4$); producing medicine-related information bulletins ($n = 3$); educating others ($n = 2$); providing clinical pharmacy services ($n = 2$); auditing medication safety ($n = 1$) and producing weekly information bulletins ($n = 1$).

According to the respondents, MI questions received were most commonly related to the physicochemical incompatibilities of medicines ($n = 5$), dosage and administration ($n = 5$), and storage and shelf life

Table 1

Medicines information services provided by staff in the university hospital pharmacies (n = 5).*

Medicines information services	n
Answering medicines information questions	5
Producing medicine-related instructions	5
Producing medicine-related information bulletins	5
Providing medicines information education to ward and hospital pharmacy personnel	5
Educating of the hospital formulary	4
Medication counselling for patients on a ward	4
Medicines information auditing / medication safety auditing	2
Producing medication review services	2
Being a member of a pharmacotherapy working group	1
Being a member of a pharmacotherapy plan working group	1

* Derived from ´Yes´/´No´ questions and open-ended question for ´Other drug information services´.

Table 2

The most commonly asked medicines information questions in the university hospitals (n = 5).*

Medicines information questions	n
Physicochemical incompatibilities	5
Dosage and administration	5
Storage and shelf life	5
Reconstituting of IV-medicines	4
Indication	1
Adverse effects	1
Interactions	1
Dosage in children	1
Disposal of the medicines and handling of pharmaceutical waste	1
Medicines availability	1

* The respondents were asked to choose five most commonly asked MI questions from a list provided in the questionnaire.

($n = 5$) (Table 2). All five organizations produced different kinds of medicine-related instructions (Tables 1 and 3) with or without multiprofessional collaboration. The instructions most commonly produced with other professionals were related to high-alert medications.

In addition to multiprofessional collaboration in producing instructions, pharmacists collaborated with clinical pharmacologists, especially in the procurement of medicines, in three university hospital pharmacies. In three hospitals, partly different organizations than mentioned above, MI pharmacists collaborated with their colleagues working in other hospital pharmacies, producing, e.g. medicine-related instructions.

3.2.3. Development of medicines information services

The respondents in three organizations reported that MI practices had been developed locally during the previous two years: a new MI database has been taken into use; standard operating procedures for MI had been prepared; the number of published medicine-related information bulletins and medication safety bulletins had increased; the access of healthcare professionals to MI had been improved; and the number of MI pharmacists had been increased. In two organizations, the MI activities had remained the

Table 3

Medicine-related instructions produced with or without multiprofessional collaboration* in the university hospital pharmacies (n = 5).**

Medicine-related instructions	n
Instructions related to high-alert medications	5
Multiprofessional collaboration is always/almost always utilized when writing instructions	4
Multiprofessional collaboration is sometimes utilized when writing instructions	1
Instructions related to specific products (a broader summary of the product, e.g. dosage, dosing instructions, adverse effects)	5
Multiprofessional collaboration is always/almost always utilized when writing instructions	3
Multiprofessional collaboration is sometimes utilized when writing instructions	2
Instructions related to shelf life of opened packages, reconstituting of IV-medicines and shelf life of reconstituted IV-medicines	5
Multiprofessional collaboration is always/almost always utilized when writing instructions	1
Multiprofessional collaboration is sometimes utilized when writing instructions	3
Multiprofessional collaboration is not utilized when writing instructions	1
Instructions related to crushing and/or splitting the tablets, and opening the capsules	5
Multiprofessional collaboration is always/almost always utilized when writing instructions	1
Multiprofessional collaboration is not utilized when writing instructions	4
Instructions related to dilution and reconstitution of intravenous antibiotics	4
Multiprofessional collaboration is always/almost always utilized when writing instructions	1
Multiprofessional collaboration is sometimes utilized when writing instructions	1
Multiprofessional collaboration is not utilized when writing instructions	2

* Multiprofessional collaboration in this context means that medicine-related instructions have been produced by pharmacists in collaboration with physicians, nurses, dieticians and/or other healthcare professionals.

** Derived from ´Yes´/´No´ questions and ´Yes´ answer provide an additional question of multiprofessional collaboration.

same or development had been slow, however, one of the organizations reported plans to develop MISs further by employing more MI pharmacists and a medication safety officer (a pharmacist) in the next two years.

3.3. Interviews

3.3.1. Proposal of establishing five MICs in Finland

In most interviews (n = 11/13), the participants viewed positively the proposal of the National Medicines Information Network of establishing five MICs (theme two of the interview guide). However, one physician had no opinion and another was critical of the five-center model and would have preferred one nationwide center. He pointed out that resources should be brought together in order to obtain one strong center rather than decentralizing the resources among several smaller ones.

Indeed, during the interviews, some of the participants suggested that, administratively, there could be one national center with five operational units. Moreover, it was suggested that one or two centers could offer MISs for the most demanding pharmacological cases and MI questions, while all other centers could provide answers for less complex MI questions related to the hospital's own formulary. If necessary, one university hospital pharmacy was even willing to take the role of the national leader. On the other hand, some interviewees preferred equal contribution, without a leading center. Some interviewees proposed that, if five MICs were established, these MICs should also be active in sharing information at the national level, collaborate internationally and possibly, collaborate in, and contribute to, producing Current Care Guidelines that are national, independent, evidence-based clinical practice guidelines.[42]

3.3.2. Perceptions of the opportunities of the proposed five-MIC network model

The interviewees identified a number of opportunities associated with the proposed five-MIC network model (Table 4) (theme two of the interview guide). It was thought that the establishment and networking of the five MICs would give a formal status and role for the work of the centers. As the most demanding medical care and highest expertise is centered in these five university hospitals, the location of the MICs within these hospitals was seen as optimal. It could bring many advantages related to e.g. knowledge of the operating environment and the practices in the hospitals and networking through the existing personal connections. Indeed, networking between the MICs might contribute to the harmonization of practices and the MICs could divide their tasks so that one MIC could be specialized in, and responsible for, a particular pharmacotherapy area. Many opportunities were also seen in multiprofessional collaboration bringing together new perspectives and broader knowledge. In all interviews, the representatives considered multiprofessional collaboration in positive terms.

3.3.3. Perceptions of the challenges of the proposed five-MIC network model

The interviewees identified several challenges related to the MICs and their collaboration (Table 5) (theme two of the interview guide). A lack of financial and human resources were the most discussed themes. However, the representatives suggested a number of potential funders; e.g. hospital districts or the government. A lack of human resources can delay the establishment of the MICs as not all university hospitals have appointed an MI pharmacist or clinical pharmacologist. Some challenges related to multiprofessional collaboration of physicians and pharmacists, e.g. in relation to responsibilities, interaction between healthcare professionals, collaboration and prejudices, were also described.

3.3.4. Need for national guidance for the operation of MICs

In most interviews (n = 8/13), the participants recommended that the operation of the MICs needed national guidance provided by the Ministry of Social Affairs and Health, the Finnish Medicines Agency (Fimea), hospital districts, university hospitals, one of the MICs, or by a steering group (theme three of the interview guide). It was perceived that joint strategic minimum objectives and tasks should be set to ensure the uniformity of the operation in all MICs. The national guidance could evolve: one

Table 4

Identified opportunities of the proposed network model of the five Medicines Information Centers (individual (n = 10), pair (n = 2) and group (n = 1) interviews; in total n = 13).

Opportunities	Typical quotes from the interviews

Status and role
 	
• MICs may have an official status and mandate to foster MI nationally in line with defined strategic objectives
• MICS may have special tasks assigned at national level, for example, enhancing the uptake of biosimilars
• Medicines information and medication safety may have a synergy advantage in the promotion of rational pharmacotherapy
• MICs may have an active role in enhancing information sharing and collaboration with stakeholders
  o sharing medicines information for citizens (e.g. via Health Village -website∗)
  o collaborating with, and offering help for, nursing homes
  o collaborating with media and press
	'If there were such officially centers, it would give those centers a formal and visible mandate. It would give visibility and probably would strengthen that activity all in all.'
	- Physician 1, in an individual interview
	'I want to emphasize that the need for information for professionals should not be underestimated and I would like to see this center issue as an answer to it. And the patient and citizen perspectives come through a Health Village -website∗ and communication.'
	- Physician 2, in an individual interview

Location at the university hospital area • It may be easier to manage and guide own tertiary care catchment area's health care units when the knowledge of the local hospital formulary and practices are more familiar. • Nearness to university hospitals may improve to see problems related to medicines and training needs. • Pharmacists and clinical pharmacologists may already have personal network at hospital when it is easier to get in touch with people and influence the practice of colleagues.	`The university hospital is a good location because it clearly has a responsibility of its own responsibility area and it is able to guide things provincially.' - Physician two, in an individual interview  `If it is completely separate, you are not close to the care. Here you have a personal network, it is also very important.' - Pharmacists in a group interview 1
Policies and responsibilities • MICs may have harmonized practices, however, division of tasks and responsibilities can be done. • MICs may partly eliminate the duplicate work by networking and sharing information with each other.	'In a way, utilizing the resources of others and maybe some division of tasks can be done in medicines information work.' - Pharmacist 1, in an individual interview 'It would harmonize practices. Finland is quite a small country, so maybe some issues could be done at the same way.' - Pharmacist in a pair interview 1
Multiprofessional collaboration • Pharmacists and clinical pharmacologists have a different competence profile, potentially leading to learning from others, complement and depth each other's knowledge. • Medicines information needs may be detected more easily at different stages of the pharmacotherapy process when pharmacists and clinical pharmacologists observe it from the different perspectives. • It may be easier to implement guidelines/instructions when they are produced multiprofessionally.	'The questions are very challenging, which may require reflection from slightly different perspectives, not only the pharmaceutical perspective but also the medical care perspective is needed.' - Pharmacist in a group interview 1

∗ Health Village is a public website, produced by university hospital districts, which offers health information and support to all citizens and tools for health care professionals. Content of website is produced in collaboration with experts and patients.

representative thought that the MICs could operate under a steering group at the beginning and, later, one of the MICs could have a coordinating and guiding role. In the five remaining interviews, the representatives

Table 5
Identified challenges of the proposed network model of the five Medicines Information Centers (individual ($n = 10$), pair ($n = 2$) and group ($n = 1$) interviews; in total $n = 13$).

Challenges	Typical quotes from the interviews
Financial resources	'It probably also depends on how this cooperation can be organized, whether is it co-financed or more that everyone finances it themselves.' - Pharmacist in a group interview 1
• It may be challenging to determine how the activity is funded. Potential funders might be hospital districts, university hospital districts, university hospitals or government. • The activity might need separate start-up funding and long-lasting ongoing funding. The activity cannot be financed by service fees because MISs are free of charge.	
Human resources	'Challenge is that where you can find qualified clinical pharmacologists.' - Pharmacist in a pair interview 2
• There may be lack of human resources. In some university hospital pharmacies, there are no appointed MI pharmacists and in some university hospital cities, there is no clinical pharmacologist or specialization program for clinical pharmacology.	
Multiprofessional collaboration	'If you are not used to work in a multiprofessional way, when you don't know each other very well and there may be prejudices. If not seeing and not being able to appreciate enough other professionals, there might be this kind of prejudice problem at least at the beginning of this type of operation.' - Physician 1, in an individual interview
• Pharmacists and clinical pharmacologists may have prejudices and lack of appreciation towards others work, unfamiliarity of multiprofessional collaboration. • Challenges may be result from unclear responsibilities, reconciling different opinions and interaction between personnel.	

thought that there was no need for national guidance or did not comment the issue.

3.4. Mixed-methods

The current MISs provided by pharmacists in the university hospital pharmacies offer both facilitators and barriers for a potential transition and development of new MI operations and forming of national MICs. The limited human resources pose challenges for expanding the services; however, the similarities in the existing MISs and their provision could provide an opportunity to share the work with colleagues and to increase collaboration. Even though no one clear funder for the MICs emerged in the study, many options were mentioned.

4. Discussion

This national census study explored the current status of MISs and the perceptions of pharmacists responsible for providing and developing MISs, and medication safety, and physicians in key positions in university hospitals and departments of clinical pharmacology, of the proposal for establishing national MICs. With a mixed methods study the barriers and facilitators of potential transition from the current state of the MISs in the university hospital pharmacies to the forming of national MICs were examined. The participants in this study confirmed that MISs of the university hospital pharmacies are quite similar, but the human resources allocated to these services vary among the organizations. The existing expertise of the pharmacists and the MISs provided by the university hospital pharmacies provide a good basis and preconditions for expanding operations of MI and by increasing collaboration between the hospital pharmacies synergies could be achieved in providing MISs, or even forming a national MIC or MICs.

Our study supported the national proposal to establish the five MICs. The expected opportunities of the MICs were related to their official status, location, multiprofessional collaboration and collaboration between the MICs. By increasing multiprofessional collaboration and collaboration between different organizations, limited resources can be pooled.[43] Collaboration could be developed at both micro and macro levels: locally in the hospitals; and nationally between different hospitals. Multiprofessional collaboration between healthcare professionals (pharmacists, nurses and physicians, including clinical pharmacologists) could be increased locally, e.g. in the preparation of medicine-related instructions and information bulletins, as well as in training. MICs located in university hospitals, i.e. in tertiary care, might also guide and support MIS provision in primary and secondary care within the same tertiary care catchment area.

In our study, national guidance for the MICs was seen as desirable. This can be seen as a need to define the principles of the operation of the MICs and strategic goals, as well as, evaluate the operation of the centers. Synergistic benefits could be obtained if the advisory body would promote nationally both MI and medication safety. Accurate MI is a requirement for the safety of the medication process and active multiprofessional collaboration ensures medication safety for the patient.[44–46] To ensure medication safety, good MI practices are essential and it is worth continuing to invest in its development.[44]

The most essential MIS; answering medicines-related questions, is the same in our study as in previous literature.[5] Previous studies have found that MI specialists who answer to MI questions have to have excellent skills in pharmacotherapy, literature search, critical evaluation, synthetization of information and communication.[47–49] Among others, comprehensive MI sources such as access to MI databases are critical issues to ensure reliable and up-to-date MI. Our study showed some shortcomings in the access to MI databases for MI pharmacists and need for providing more training in MI searching skills especially to junior pharmacists and pharmacists who are working on the wards. When developing the MISs, it would be necessary to invest in a sufficient number of highly trained MI specialists and comprehensive sources of MI.

In our study, the most commonly asked questions in the university hospital pharmacies were product centered questions: physicochemical incompatibilities; dosage and administration; and storage and shelf life, rather than patient-specific therapeutic questions. In previous studies, the most commonly asked questions have been related to ADRs and interactions.[7,11] By increasing multiprofessional collaboration especially with clinical pharmacologists, the skills of pharmacists could be evolved from product centered expertise towards more clinical patient care.[45] Pharmacists working on the wards are increasingly solving challenging patient-specific problems. This also change the work of MI pharmacists more patient-centered as they help and support pharmacists working on the wards.

4.1. Study strengths and limitations

This census study was conducted at the macro or national level, i.e. it represented pharmacists responsible for providing and developing MISs and medication safety in all university hospital pharmacies and physicians in key positions in university hospitals and departments of clinical pharmacology in Finland, which was the main strength of this study. However, other stakeholders, such as the national competent authority (Finnish Medicines Agency, Fimea) or the Ministry of Social Affairs and Health were not included, because this study focused on the opinions of practicing healthcare professionals. All identified experts in university hospital pharmacies and other relevant hospital organizations were successfully recruited for the survey and the interviews. Another strength of this study was that only one researcher interviewed all participants enabling a congruent interview process[50] and observation of the saturation of the data. While only one researcher analyzed the data, which is a limitation of this study, rigorous iterative content analysis processes were followed and the coding and interpretation were discussed with the research group for verification.

In three interviews, there were participants who had been involved in the National Medicines Information Network with planning or proposing the establishment of MICs in Finland, and thus, perhaps expectedly, they viewed positively the proposal of establishing five MICs. This might have contributed to more positive overall results on this proposal, however, also critical views were gained and others were also positive. Furthermore, it has to be acknowledged that all the authors are members of the National Medicines Information Network, which provided the motivation for conducting this study.

The results of this study may be transferable to other countries where national MICs have not been established or to countries where local MICs serving healthcare professionals in a similar context have not been established and may be utilized as an example on how nationwide or local development of MI services and centers may be conducted.

5. Conclusions

The existing expertise of the pharmacists and the similarities in the MISs provided by pharmacists in the university hospital pharmacies seem to provide a good basis and preconditions for expanding MI operations and forming MICs at the national level. By pooling current limited resources, synergies could be achieved and MISs, and potentially MICs, developed. The establishment of MICs may enhance utilization of networking and multiprofessional collaboration in producing MISs at the national level.

Authors` contributions

All authors participated in designing the study and development of the survey questionnaire and interview guide. The first author was responsible of collecting and analyzing the study data and drafting the manuscript. All authors participated in discussing and verifying the analysis and in the critical revision and the final approval of the manuscript.

Declaration of Competing Interest

All authors are members of the National Medicines Information Network. One of the authors participated in the interviews in her role as an MI pharmacist.

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