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Medication safety strategies in European adult, paediatric, and neonatal intensive care units: a cross-sectional survey

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ABSTRACT

Objectives Patients in intensive care units (ICUs) are potentially more vulnerable to medication errors than patients admitted to general wards. However, little is known about medication safety strategies used in European ICUs. Our objectives were to explore the strategies being used and being planned within European ICUs, to identify areas of variation, and to inform recommendations to improve medication safety in this patient group.

Methods We distributed an online survey, in seven European languages, via professional networks and social media. The survey explored a range of medication safety strategies and whether they were in use (and if so, whether fully or partially implemented) or being planned. Demographic information about respondents and their ICUs was also captured. A descriptive analysis was conducted, which included exploring geographical variation.

Results We obtained 587 valid responses from 32 different countries, with 317 (54%) completed by pharmacy staff. Medication safety practices most commonly implemented were patients' allergies being visible for all staff involved in their care (fully implemented in 382 (65%) of respondents' ICUs), standardised emergency medication stored in a fixed place (337, 57%), and use of standardised medication concentrations for commonly used intravenous infusions (330, 56%). Electronic prescribing systems were fully implemented in 310 (53%). A pharmacist was reported to be fully implemented in 181 (31%) of ICUs, of which there was 126 (70%) where there was a pharmacist review of all ordered medication five days per week. Critical care pharmacists were most common in Northern European ICUs (fully implemented to ICUs in 102, 50%) and electronic prescribing in Western Europe (108, 65%).

Conclusions There is considerable variation in medication safety strategies used within European ICUs, both between and within geographical areas. Our findings may be helpful to ICU staff in identifying strategies that should be considered for implementation.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Patients in intensive care units are potentially more vulnerable to medication errors than patients admitted to general wards. Little is known about medication safety strategies used in intensive care units across Europe.

WHAT THIS STUDY ADDS

⇒ We identified medication safety strategies in use and being planned within intensive care units across European hospitals, together with variation both between and within geographical areas. The strategies most commonly in place across Europe were patients' allergies being visible for all staff involved in their care, standardised emergency medication stored in a fixed place, and use of standardised medication concentrations for regularly used intravenous infusions.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Our findings may be helpful to ICU staff, healthcare leaders and policymakers in identifying strategies that should be considered for implementation in their own ICU contexts.

INTRODUCTION

Medication errors (MEs) are a leading cause of morbidity and mortality.[1] Patients admitted to intensive care units (ICUs) are potentially more susceptible to MEs than other patients, as they receive complex medication regimens that may be more prone to error, and the medications concerned are often high-risk.[2] As ICU patients generally have less physiological reserve and are less able to play a part in their own safety due to sedation, MEs may also be more likely to result in harm.[2 3]

Although MEs in patients admitted to ICUs can happen at any stage of the medication use process,[2] MEs have been most commonly reported at the administration stage (9.8 to 63% of all MEs reported),[4 5] followed by prescribing (6.8 to 43%),[6 7] transcription (3.3 to 18.4%)[5 6] and dispensing (0.78 to 25%).[5 6] However, differences in definitions and methods limit our ability to compare different studies.

Various error prevention strategies have been shown to reduce MEs in at least some ICU settings, for example, computerised prescriber order entry (CPOE), clinical decision support systems (CDSS), barcode medication administration (BCMA) technology, smart infusion pumps, clinical pharmacists, medication reconciliation and education.[5 8 9] Surveys from Spain,[10] and more recently from Australia and New Zealand[11] describe error prevention strategies used in ICUs in these countries. However, little is known about ME prevention strategies in ICUs across Europe, or how these vary geographically. We therefore aimed to explore medication safety

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strategies currently in use and being planned within ICUs across Europe, to identify areas of variation and to inform recommendations for medication safety strategies for European ICUs.

METHODS

We used an online cross-sectional descriptive survey, developed by a working group of three intensivists, an ex-ICU nurse, and four pharmacists with a critical care background. This was part of a larger programme of work to develop recommendations for medication safety in European ICUs.[12] The present study is reported according to the Checklist for Reporting Results of Internet E-Surveys (CHERRIES).[13]

Survey instrument

Survey questions were designed through a collaborative and iterative process, drawing on previous surveys.[2 10 11] The final draft of the survey was piloted among several healthcare professionals (HCPs) with ICU experience, and minor changes were made to aid clarity. The survey was then uploaded to the online 'easyfeedback.com' platform before being tested again to ensure usability. Using a process of translation followed by back-translation, by two different bilingual speakers for each language, the survey was translated from English (online supplemental appendix 1) into Estonian, French, German, Italian, Slovenian and Spanish, to provide more inclusive access across Europe.

The survey invited respondents to review a list of about 40 strategies for ME prevention and to indicate whether these were in use or being planned for use in their ICU. These practices included: (1) general medication safety practices, such as double-checking and medication reconciliation processes, guidelines, and formularies; (2) technologies, such as CPOE and BCMA; (3) pharmacy services, such as pharmacy top-up of medications and specialist critical care pharmacists; and (4) incident reporting and learning. Some questions were 'nested', so that respondents were only asked more detailed questions if a particular strategy was in use. The survey also included a 'free text' response section for participants to add any additional strategies that were not listed. The survey was designed to facilitate completion on both desktop and mobile devices, and extended to about 15 online pages.

Responses to the questions were recorded using a 5-point scale, allowing respondents to select whether a practice was: (1) fully implemented for all patients, medication orders, medications or staff; (2) fully implemented for some patients, medication orders, medication or staff; (3) partially implemented for some/all patients, medication orders, medication or staff; (4) planned to be implemented within the next 5 years of the survey; (5) not implemented. Respondents could also select the option 'Unknown' if they did not know the extent to which a strategy was implemented in their ICU. None of the questions were mandatory. Respondents were able to review and change their answers at any time, by navigating through the survey using 'Back' and 'Forward' buttons, before submitting.

The survey also requested demographic data, including the profession and gender of the respondent, the type and size of their ICU, and the country in which they worked. Names of respondents and their organisations were not recorded.

Participant recruitment

Participants were invited through the European Association of Hospital Pharmacists (EAHP), and other relevant national and European professional networks relating to critical care, using emails, social media, as well as promotion at the 2022 EAHP Congress. Any HCPs working in any European ICU (adult, paediatric, neonatal, medical and/or surgical), or professionals with a specialist medication safety role in their organisation, were eligible to take part. Recruitment took place between 25 March and 8 May 2022. Participation was voluntary and anonymous; participants were asked to provide their informed consent before completing the survey. Due to the 'open' method of dissemination, it was not possible to limit responses to one per organisation or to calculate a response rate.

Analysis

Anonymous survey responses were collated, reviewed, translated into English and cleaned if necessary to correct spelling errors and ensure consistency. Responses that did not meet the inclusion criteria were excluded, that is, if respondents indicated a country outside of Europe, did not confirm that they had read the participant information or consented to participate, or if they left all the questions relating to ME prevention practices blank. Surveys that did not state a country of practice were retained since the survey had been actively promoted only in Europe. Partial responses to the survey were included provided that at least some of the questions relating to ME prevention strategies had been completed.

Descriptive analysis was used to identify the medication safety practices most commonly used, using Microsoft Excel. For a selection of key medication safety practices, responses were also analysed by European region. Countries were grouped as Northern, Eastern, Western, and Southern Europe using the United Nations' classification.[14] For the free text question on any additional safety practices, responses were grouped and summarised thematically.

Ethical considerations

Ethical approval was given by University College London (UCL) Research Ethics Committee (Project ID: 15283.003). The 'easyfeedback.com' platform is General Data Protection Regulation compliant and allowed us to collect data without recording IP addresses. No personally identifiable data were collected, and the data included no information that would have reasonably allowed the identification of participants. No incentives were provided. The first page of the survey comprised an explanation of the study, how long the survey would take to complete, how the data would be used, researchers' contact details, and a 'tick box' to indicate that participants had read this information and gave consent to participate.

RESULTS

A total of 1071 survey responses were received. Thirty-five were removed due to 21 respondents not ticking "Yes" to having read the participant information and/or that they gave consent, and 14 that specified a country outside of Europe. Of the remaining responses, 449 (43%) only included answers to the demographic questions, with questions relating to medication safety practices all left blank; these were also removed. Twelve responses that did not specify a country were retained. Following this process, 587 surveys (55% of all responses) remained from 32 countries (table 1). Respondent demographics are presented in table 2. Countries with the highest numbers of responses were Spain (n=99, 17%), France (n=79, 13%), Germany (n=43, 7%), United Kingdom (n=43, 7%), Estonia (n=42, 7%), Ireland (n=42, 7%) and Finland (n=38, 6%).

During analysis it was identified that five questions were missing from the Slovenian, German or French versions of

Table 1 Number of respondents from the different European countries, and regions

European regions and their countries	Number of responses
Northern Europe	202
Denmark	3
Estonia	42
Finland	38
Iceland	1
Latvia	4
Norway	3
Ireland	42
Sweden	26
United Kingdom	43
Southern Europe	185
Bosnia and Herzegovina	1
Croatia	3
Greece	3
Italy	30
Malta	3
North Macedonia	1
Portugal	6
Serbia	3
Slovenia	28
Spain	99
Turkey	8
Western Europe	167
Austria	8
Belgium	12
France	79
Germany	43
Luxembourg	3
Netherlands	3
Switzerland	19
Eastern Europe	21
Bulgaria	2
Czech Republic	4
Hungary	2
Romania	10
Slovakia	3
Not stated	12
TOTAL	587

the survey due to problems in uploading these to the online platforms; total responses therefore vary for some questions answered in these languages.

Medication safety practices

General medication safety practices

Of 19 general medication safety practices explored, only four were fully implemented for all patients, orders, medications, or staff in 50% or more of respondents' ICUs (figure 1). These were patients' allergies being clearly visible for staff involved in prescribing, reviewing, or administering medication (382, 65% of respondents' ICUs), storage of standardised emergency medications in a fixed place (337, 57%), use of standardised concentrations for regularly used intravenous infusions (330, 56%), and use of oral/enteral syringes that are incompatible with intravenous lines (321, 55%). Patients' allergies being clearly visible was also the most commonly fully implemented practice in three of the four European regions (Northern: 150 (74%), Southern: 124 (67%), Western: 97 (58%)), and joint most common in Eastern Europe (8, 38%) (online supplemental appendix 2).

Practices relating to medication reconciliation processes were often in use to some extent, being more likely to be partially implemented, or fully implemented in some medications or patients, rather than being implemented in all situations.

The medication safety practices least commonly reported in respondents' ICUs ('no activity' or 'being planned in the next 5 years') were separation of high-risk medications from other medications (212, 36% with 'no activity' or 'being planned'), independent double-check for the preparation (246, 42%) and administration (255, 43%) of all medications, and independent double-check for administration of high-risk medications (213, 36%).

Use of technology

Electronic prescribing (EP)/CPOE systems were the most widely implemented technologies, being implemented for at least some patients, orders, medications, or staff in 381 (65%) of all respondents' ICUs, and fully implemented in 310 (53%) (figure 2). However, this varied across regions with the least usage in Northern Europe (implemented to some degree in Northern: 119 (59%), Southern: 119 (64%), Western: 123 (74%), Eastern: 16 (76%) (online supplemental appendix 3). EP/CPOE systems were fully implemented in 271 (55%) adult ICUs, 21 (54%) paediatric ICUs, and in 7 (37%) neonatal ICUs. Of the 381 ICUs with EP/CPOE, the most common type of CDSS was prepopulated templates for commonly used critical care medications (307, 81%); the least common was the use of CDSS to identify and differentiate similar drug names (105, 28%) (online supplemental appendix 4).

Smart infusion pumps for intravenous medication were implemented to some degree in 276 (47%) of ICUs and fully in 123 (21%). This was the second-most common technology, being implemented to some degree in respondent ICUs across Northern (110, 54%), Southern (85, 46%), and Western (74, 44%) European regions, although less common in Eastern Europe (4, 19%) (online supplemental appendix 3).

Automated dispensing cabinets, and use of BCMA to confirm patient, and medication identity were least commonly implemented across all respondents' ICUs: with no activity, or being planned in the next 5 years in 362, (62%), 395 (67%), and 334 (68%, of 491 ICUs) of respondents' ICUs, respectively. However, in Eastern Europe, BCMA was the most commonly implemented technology, being used for confirming patient and medication identity in six (29%) and five (24%) of ICUs respectively.

Where these technologies were not in use, respondents often reported plans to introduce them in the next 5 years (figure 2).

Pharmacy services

The pharmacy service most often fully implemented was pharmacy-led top-up of medication (294, 50%) (figure 3), although this was mainly accounted for by more widespread use in Western (68, 65%) and Southern Europe (109, 59%) (online supplemental appendix 5). A critical care pharmacist was reported as being 'fully implemented' in 181 (31%) of respondent ICUs, while 192 (33%) did not have this service at all. Critical care pharmacists were reported to be implemented to some degree in 270 (55%) of adult ICUs, 23 (59%) of paediatric ICUs, and 11 (58%) of neonatal ICUs. Critical care pharmacists were most common in Northern Europe, where 151 (75%) had this service to some degree. Medication review 5 days a week by a critical care pharmacist was fully implemented in 173 (29%)

Table 2 Demographics of 587 survey respondents.

	Doctor or anaesthetist	Nurse, midwife, or student nurse	Pharmacist or pharmacy manager	Other	Not stated	Total
Profession	**157**	**107**	**317**	**2**	**4**	**587**
Gender						
Female	72	80	239	2	1	**394**
Male	84	26	72			**182**
Non-binary		1				**1**
Not stated /prefer not to say	1		6		3	**10**
Specialty of ICU						
Adult ICUs						**494**
Adult medical	18	18	53			**89**
Adult surgical	15	8	17	1	1	**42**
Adult mixed medical / surgical	94	56	169			**319**
Adult cardiac/cardiac surgery	9	5	10			**24**
Other/other mixed specialities	4	5	11			**20**
Paediatric ICUs	9	6	24			**39**
Neonatal ICUs	3	1	15			**19**
Mixed population ICUs	2	3	3			**8**
Not stated	3	5	15	1	3	**27**

'Other' profession category included 'manager' and 'medical technologist' professions. 'Other/other mixed' ICU specialty category included gynaecology, infectious diseases, neurology/neurotrauma/neurosurgery, oncology, burns, "mixed", numerous mixed specialities. Mixed population ICUs category included ICUs serving mixed populations (adults, paediatrics, neonates).

of respondent ICUs. Medication review 7 days a week was less common, and pharmacist authorisation of every medication before administration was comparatively rare.

Incident reporting and learning

Incident reporting systems were implemented to some degree in 452 (77%) of respondents' ICUs (figure 4). Discussions surrounding medication incidents and corrective measures, and medication safety audits, happened to some degree in 420 (72%) and 282 (48%) ICUs, respectively. A medication safety officer was fully available for 203 (35%) of the hospitals concerned.

Within this category, incident reporting systems were the most common practice in respondent ICUs in Northern Europe (implemented to at least some extent in 166 (82%)), Southern Europe (134, 72%), and Western Europe (139, 83%), while in Eastern Europe, regular discussions about medication incidents were more common instead (14, 67%) (online supplemental appendix 6).

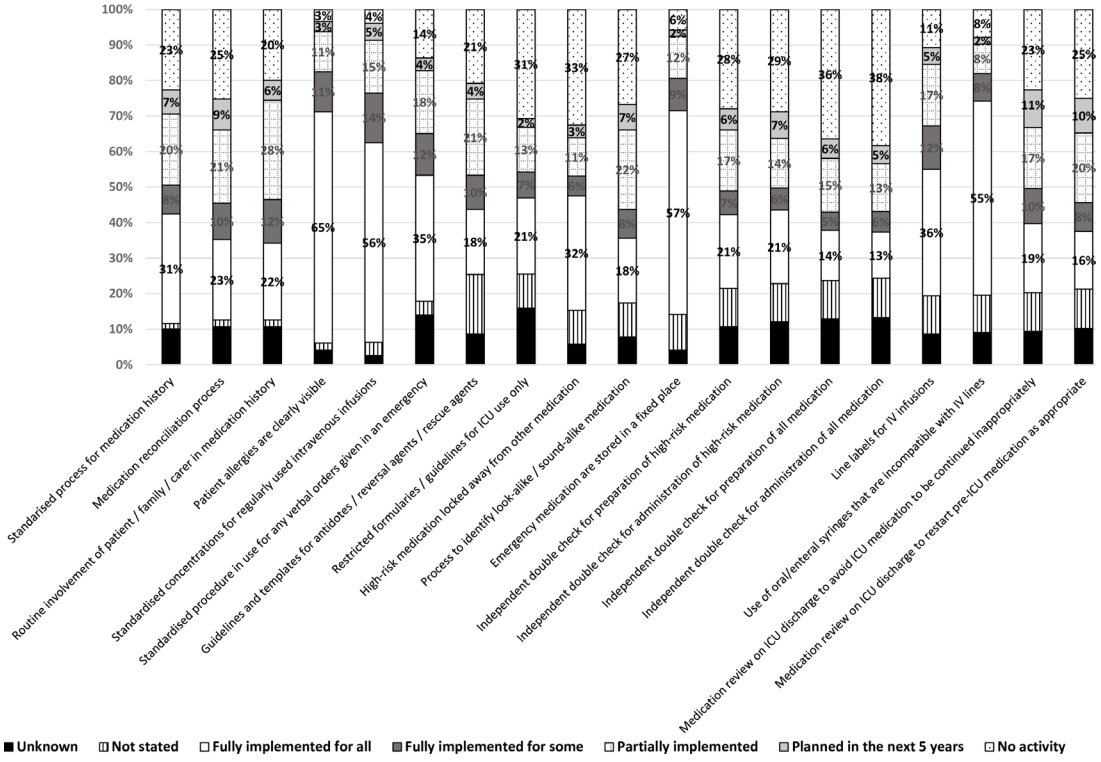

Figure 1 Stacked bar chart of general medication safety practices in respondents' ICUs. IV: intravenous

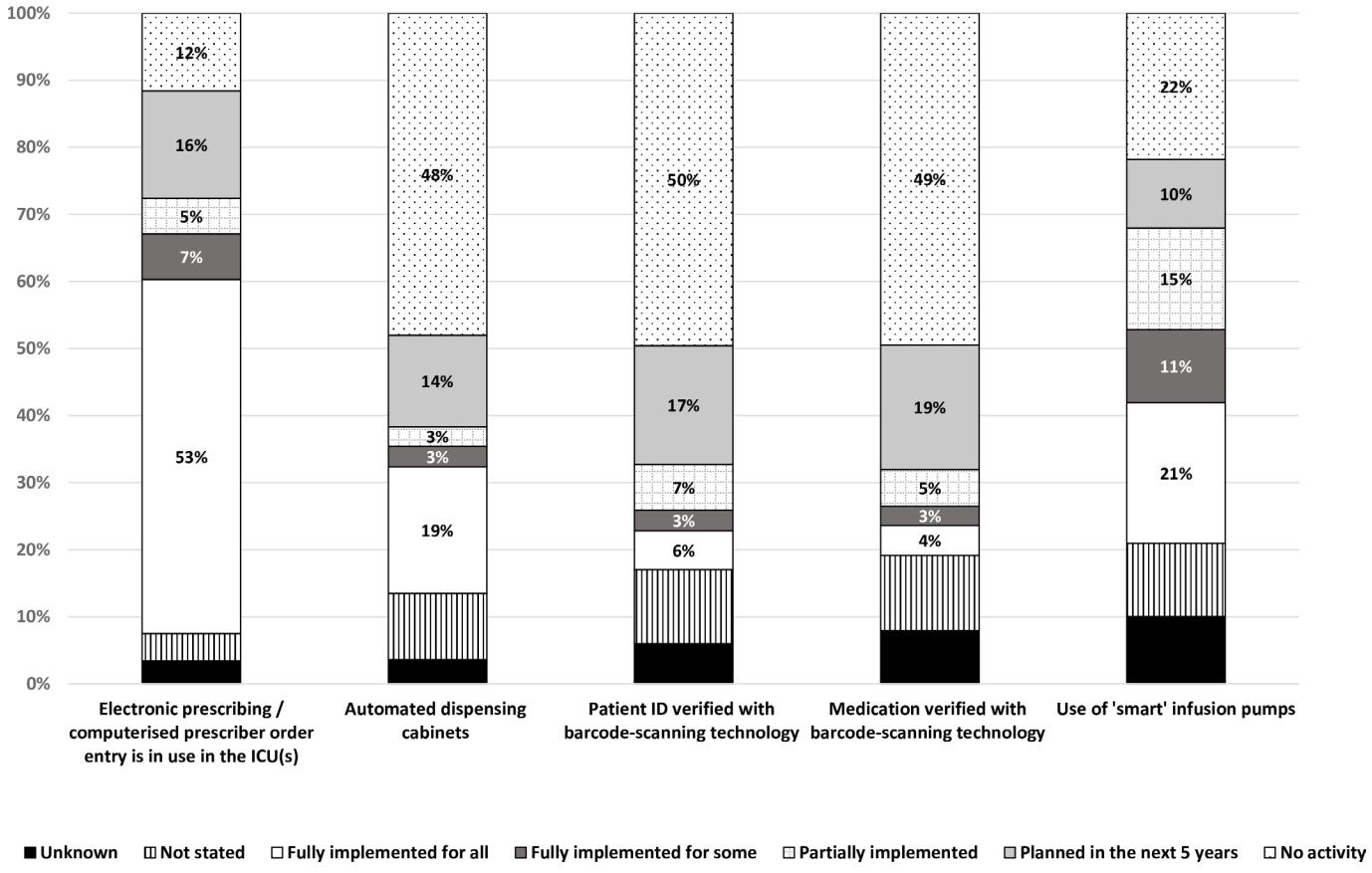

Figure 2 Stacked bar chart of technology used in respondents' ICUs. ID: identity.

Other medication safety strategies

Sixty-eight respondents provided free text answers describing other safety practices used in their ICUs that were not mentioned elsewhere. Six themes were identified.

Resources

Respondents listed a variety of resources used to aid standardisation and safety, including unit- or hospital-specific formularies, do/do-not crush lists, Y-site compatibility charts, and national guidelines and standards.

Technology

Many resources were also described being used as mobile applications. Other technologies included electronic health records, syringe labelling systems, NRFit (neuraxial) connectors, unit dose dispensing, 'computers on wheels', and tablet computers.

Safety groups

These included multi-disciplinary teams, safety/risk huddles and incident management teams.

Pharmacy involvement

Respondents reported pharmacist review of all high-risk medications, being involved in therapeutic drug monitoring, and developing information sheets. Pharmacists were reported to lead multi-disciplinary medication safety teams and manage analgesia and sedation. A pharmacy technician-led dispensing service from medication trollies, and pharmacy preparation of all medicines and parenteral nutrition for neonatology were also reported. Finally, respondents listed antimicrobial and prescribing pharmacists as strategies for medication safety in ICUs.

Education

Educational material on medication safety included memos on certain medications and medication safety newsletters. Some ICUs used videos to role-model good practice, and some reported practice development nurses involved in the training of ICU nursing staff. Use of private social media groups for ICU staff to share medication information was also reported.

Other safety practices

Standardised medication preparation practices included advance preparation of certain medications, ready-to-use medications, centralised intravenous services, and preparation of intravenous medications in a dust-free safety cabinet. Double-checking of infusions at shift handover was also listed. Some respondents gave strategies to minimise interruptions or distractions, such as wearing red aprons. Visual strategies included labelling syringes, infusion bags and lines using colours, International Organisation for Standardisation labels and flags, and storing medications according to anatomical therapeutic chemical code. Nursing roles such as lead clinical risk nurses, and dedicated nurses for resuscitation teams and medication preparation were also described.

DISCUSSION

Key findings

We obtained 587 usable responses from 32 European countries. We identified variations in the use of medication safety practices, both within and among countries. Practices most commonly used in all situations were patients' allergies being visible to all staff involved in their care, standardised emergency medication stored in a fixed place, and use of standardised medication

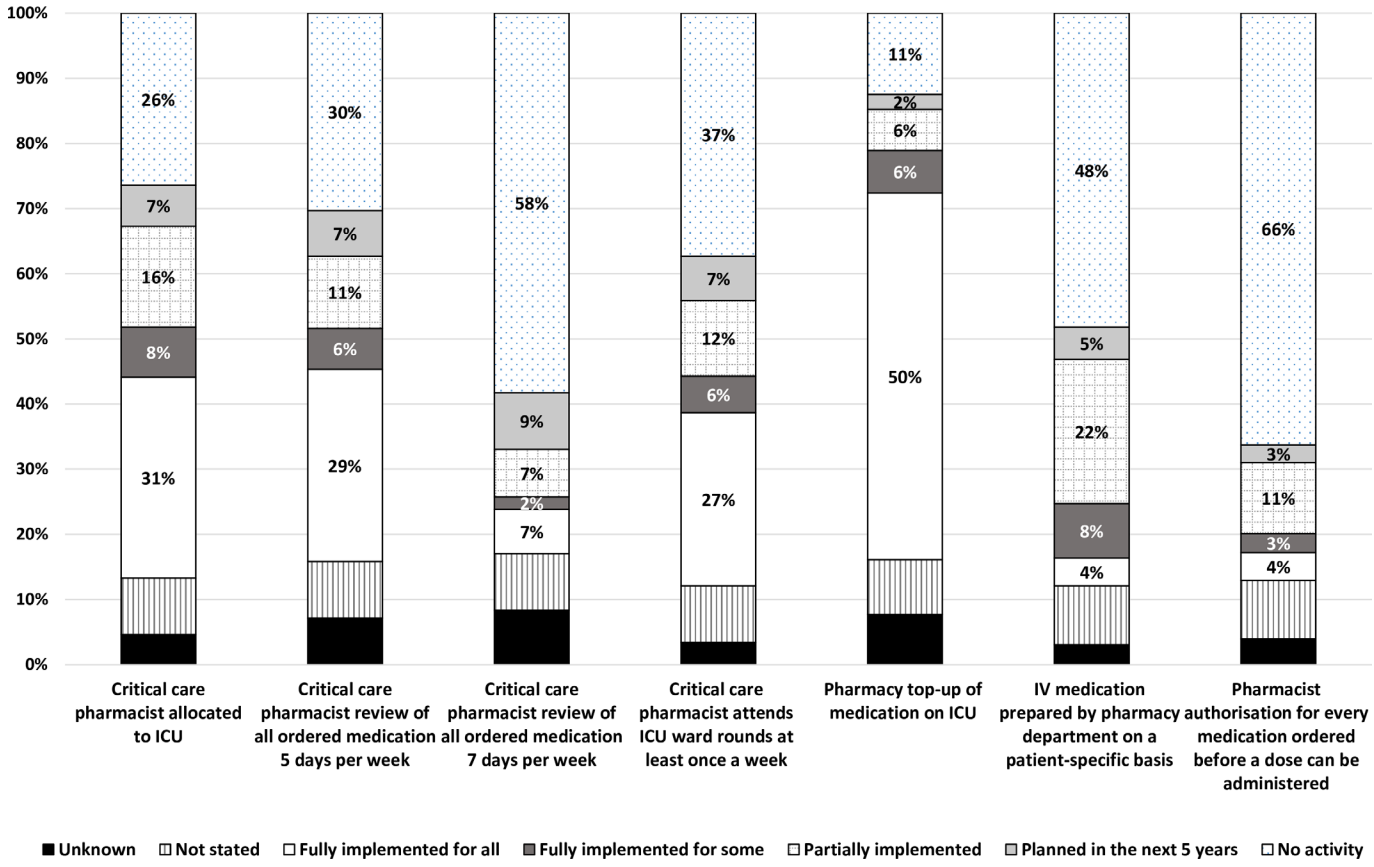

Figure 3 Stacked bar chart of pharmacy services in respondents' ICUs. IV: intravenous.

concentrations for intravenous infusions. There was regional variation in the use of some practices, such as EP/CPOE being more common than critical care pharmacists in Eastern, Southern and Western Europe, and vice versa in Northern Europe. In terms of interventions being planned for implementation in the next 5 years, these most commonly involved technology-based practices such as automated dispensing cabinets and BCMA.

Comparison with previous literature

Previous surveys have examined practice in Spain,[10] Australia and New Zealand.[11] In the Spanish study, 31% of 40 ICUs had a pharmacist allocated, and 50% were using smart infusion pumps in 2020.[10] These figures are broadly similar to the percentages of ICUs with these practices fully implemented in Southern Europe in our survey. The most commonly implemented practice in the Spanish study was patient and family education (69% of ICUs); this was not explored in our study.

In Australian and New Zealand neonatal units (NNUs), a ward-based clinical pharmacist and smart infusion pumps were the most commonly used practices, with 85% and 90% of 20 NNUs having these respectively in 2016.[11] These figures are higher than those in our study, which may reflect different practices around the world and/or the NNU context. However, unlike in our study, none of the Australian or New Zealand NNUs had BCMA technology.

Interpretation and recommendations

We have described current medication safety practices in use and being planned in European ICUs. Interestingly, many of the commonly used practices have little direct evidence to support their use, likely to be based instead on generally accepted good practices. Examples include having allergies clearly visible, emergency medication stored in a fixed place, and use of standardised medication concentrations. Some technological interventions, such as EP/CPOE have some evidence base,[15] while other patient safety practices with a relatively strong evidence base, such as critical care pharmacists,[16–19] and medication reconciliation,[20] were less widely implemented in some areas. These findings can be used by staff in ICUs, policy makers and patient safety leads to identify strategies that should be considered for implementation.

Strengths and limitations

The strengths of this work are that it is the first survey of medication safety practices in European ICUs. We obtained responses from a wide range of countries, likely facilitated by the questionnaire being in different languages. Limitations are that the 'open' method of dissemination rendered it impossible to limit responses to one per organisation or to calculate a response rate. We also had a high number of questionnaires for which respondents did not complete the questionnaire beyond the demographic questions. We suspect this may be due to potential participants starting the questionnaire and then realising that they did not have relevant expertise to complete the questions. We also had low numbers of responses from some countries, and from the Eastern European region in general, limiting comparisons at a more granular level. Some degree of response bias is possible, such as if staff from ICUs with a greater focus on medication safety were more likely to complete the questionnaire. Finally, there were some practices that were not explored in the survey, such as the use of unit dose drug distribution and some practices that respondents highlighted in their free text responses, such

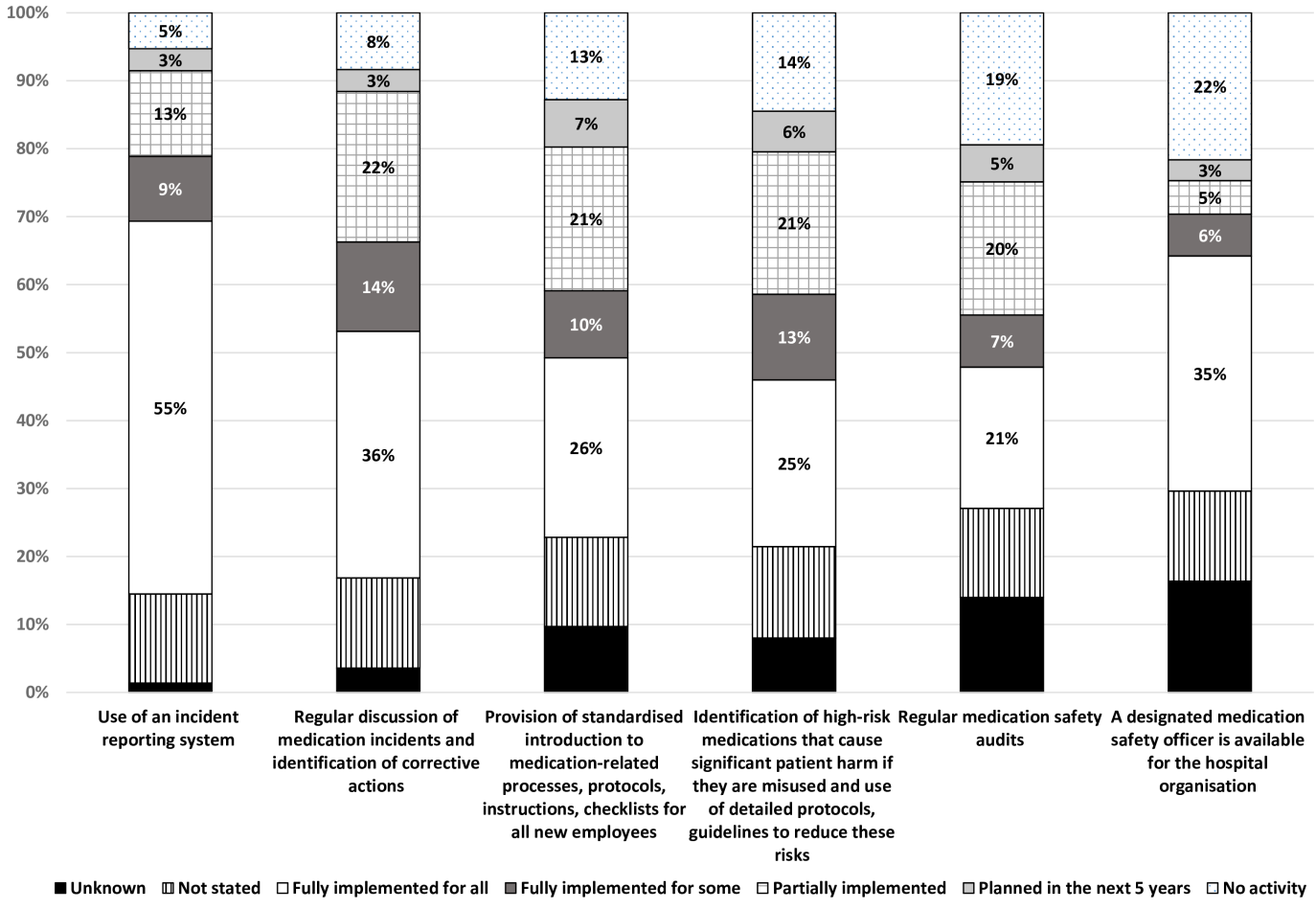

Figure 4 Stacked bar chart of incident management practices in respondents' ICUs.

as information on Y-site compatibilities and pharmacists' therapeutic drug monitoring.

CONCLUSIONS

There is considerable variation in the medication safety strategies used within European ICUs, both between and within geographical areas. Our findings may be helpful to ICU staff in identifying strategies that should be considered for implementation.

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Patient consent for publication Not applicable.

Ethics approval This study involved human participants. Ethical approval was given by University College London (UCL) Research Ethics Committee (Project ID: 15283.003). Participants gave informed consent to participate in the study before taking part.

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Appendix 1 – ICU English Language Survey

A survey to identify examples of medication error prevention strategies in use and/or being planned in European intensive care units

Participant Information (first page of online survey instrument)

You are being invited to take part in a research project. Before you decide whether or not to take part, it is important for you to understand why the research is being undertaken and what it will involve. Please take time to read the following information carefully and discuss it with others, if you wish.

Thank you for reading this.

What is the purpose of the study?

Patient safety is a priority for healthcare organizations worldwide. Due to the complex nature of the intensive care unit (ICU) setting, specific strategies for improving medication safety are likely to be particularly important. We are looking to identify medication error prevention strategies both in use and being planned in ICUs across Europe, in order to develop policy recommendations for medication safety improvement.

Why have I been invited?

You have been invited to participate as you are a healthcare professional working in an ICU setting in Europe.

Do I have to take part?

Participation is entirely voluntary. It is up to you to decide whether or not to take part. If you do decide to take part you will be asked to indicate your consent online. As your responses to the questionnaire will be anonymous, once you have submitted your responses you will be unable to withdraw. Your right to decline or withdraw from the study will in no way influence or adversely affect you. You can withdraw by closing your browser before submitting your responses, and they will not be included.

What will happen to me if I take part?

If you agree to participate, you will be invited to proceed to compete the survey, which will ask you about medication safety practices currently in use and being planned within the ICU(s) in which you work. We will also ask for some basic demographic information about you (such as your gender and profession) and about your ICU (such as number of beds, ICU specialty and country).

The survey should take approximately 10-20 minutes to complete. There will be no further involvement expected from you.
All information you provide will be confidential and your anonymity will be protected throughout the study. We are not asking participants for their names, or the names of their

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organisations. Computer IP addresses will not be collected at any point, meaning the data that you provide cannot be traced back to you or your organisation.

The raw data will be kept on password-protected computer systems at University College London for five years after publication of the study in a peer-reviewed journal or a maximum ten years after completion of the study, whichever is first.

What are the possible benefits of taking part?

There will be no immediate benefit to you from participating, but we hope that the information we receive will help us to inform policy recommendations for medication safety improvement in ICUs around Europe.

What are the possible disadvantages and risks of taking part?

We do not anticipate any risks from participating in this study. The only disadvantage is the time you need to take to complete the survey.

What if something goes wrong?

If you have a concern about any aspect of this study, please contact the Principal Investigator Professor Bryony Dean Franklin (email: bryony.deanfranklin@ucl.ac.uk*).*

What will happen to the results of the research study?

It is anticipated that the findings of the research study will be disseminated via a number of avenues, such as through a peer reviewed research paper and presentations at academic conferences. It will not be possible to identify participants from any reports or outputs of the study.

Who is organising and funding the research?

This research is organised by the Special Interest Group for the Investigation of Medication Errors in Intensive Care, as part of the European Association of Hospital Pharmacists (EAHP). The EAHP has received funding support from BD (Becton, Dickinson and Company) for the running of this project. The researchers are independent of BD and EAHP. The Principal Investigator of this study is from UCL School of Pharmacy. The findings of the study will be made available on the EAHP website in due course.

Who has reviewed the study?

The Principal Investigator has obtained approval by UCL research ethics committee (reference number: 15283.003).

Contact for Further Information

If you would like further information on any aspect of the study, then do not hesitate to contact the Principal Investigator: Professor Bryony Dean Franklin on bryony.deanfranklin@ucl.ac.uk

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CONSENT TO TAKE PART

I have read and understood the above participant information.

I consent to take part in this study and understand that continuing to complete and submit the rest of the survey indicates this consent.

SURVEY QUESTIONS

Before asking you about the medication safety strategies in use in your intensive care unit (ICU), it would be helpful to know a bit about you.

What is your profession?

- Nurse
- Pharmacist
- Physician
- Other (please state)

What is your gender?

- Female
- Male
- Non-binary / other
- Prefer not to say

What is the speciality of the main ICU that you work in?

- Adult medical
- Adult surgical
- Adult mixed medical / surgical
- Adult cardiology / cardiothoracic
- Paediatric
- Neonatal
- Other

How many inpatient beds (including ICU) does your hospital have?

How many beds does your ICU have (excluding any additional beds added due to the COVID pandemic)?

In what country is the hospital you practice/work in located?

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RESPONSE CATEGORIES FOR ALL REMAINING STATEMENTS WILL BE AS FOLLOWS:

A. There has been **no activity** to implement this.
B. This is being **planned for implementation** in the next 5 years.
C. This has been **partially implemented** for **some or all** patients, orders, medications, or staff in our ICU(s).
D. This is **fully implemented** for **some** patients, orders, medications, or staff in our ICU(s).
E. This item is **fully implemented** for **all** patients, orders, medications, or staff in our ICU(s).
F. Unknown.

For each of the following items, please indicate the extent of activity in your ICU(s).

Note that there are no 'right' or 'wrong' answers – we recognise that practices differ around the world and will be different in different units.

ADMISSION TO CRITICAL CARE

- Use of a standardised process to obtain a complete list of the medication that the patient was taking prior to admission to the ICU (medication history).
- Systematic comparison of this list of medications with the patient's current prescribed medication and ensuring that any intentional changes have been documented (medication reconciliation).
- Routine involvement of patient / family / carers in establishing the patient's medication history whenever possible.
- Patient drug allergies are clearly visible to all healthcare professionals involved with prescribing, reviewing, or administering medication.

PRESCRIBING

- Use of standardised concentrations for regularly used intravenous infusions.
- Standardised procedure in use for any verbal orders given in an emergency, including a process for retrospectively documenting the medicines and doses given.
- Electronic prescribing / computerised prescriber order entry (CPOE) is in use in the ICU

Branched question only if respondent answers C, D or E to the last question above in relation to CPOE:

- The CPOE system includes pre-populated templates for commonly used critical care medications
- The CPOE system includes support for weight-based dosing.
- The CPOE system includes reminders and/or information about monitoring parameters for high-risk medications (e.g. potassium chloride, inotropes, narcotics, sedatives, insulin, anticoagulants) that are included in the CPOE system.

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- The CPOE system includes clinical decision support to identify medications prescribed to which the patient has a documented allergy
- The CPOE system includes clinical decision support to identify drug-drug interactions
- The CPOE system includes clinical decision support to identify and differentiate similar drug names (for example, using "tallman" lettering)

Branched question only if respondent answers A, B or F to the last question above in relation to CPOE:

- Pre-printed paper templates / order forms are in use for commonly used medications.
- Paper prescribing systems include reminders and information about monitoring parameters for high-risk medications.

For all respondents:

- Guidelines or templates in use to ensure appropriate antidotes, reversal agents, and rescue agents are prescribed when necessary.
- Restricted formularies or guidelines in place to allow only intensive care prescribers to prescribe certain medications (e.g. for neuromuscular blocking agents).

PHARMACY SERVICES

- A critical care pharmacist is allocated to the ICU
- There is critical care pharmacist review of ordered medications 5 days per week
- There is critical care pharmacist review of ordered medications 7 days per week
- A critical care pharmacist attends ward rounds on the ICU at least once a week
- There is pharmacy top-up of medication stocked on the ICU.
- Intravenous medications are prepared by the pharmacy department on a patient-specific basis
- Authorisation by a pharmacist is required for every medication order before any dose can be administered

STORAGE OF MEDICATION ON THE ICU

- High-risk medications, such as high concentration potassium chloride, are stored in a separate locked cupboard or automated storage unit away from other fluids /ampoules/medications.
- There is a process for identification of look-alike / sound-alike medicines and the use of strategies to prevent mix-ups such as unique labels or 'tall-man' lettering.
- Standardised emergency medications are stored in a fixed place.
- Automated dispensing cabinets (electronic storage cabinets to control and track medications) are in use on the ICU.

ADMINISTRATION TO THE PATIENT

- Organizational policies and procedures are in place to ensure independent double check for the **preparation** of **high-risk medications**.
- Organizational policies and procedures are in place to ensure independent double check for the **administration** of **high-risk medications**.

- Organizational policies and procedures are in place to ensure independent double check for the **preparation** of **all medications**.
- Organizational policies and procedures are in place to ensure independent double check for the **administration** of **all medications**.
- Line labels are in use for intravenous infusions to prevent identification and disconnection errors.
- Routine use of oral/enteral syringes that are incompatible with intravenous lines for administration of liquid medications via the oral or enteral routes
- Verification of **patient identity** using barcode-scanning technology prior to medication administration
- Verification of **medications** using barcode-scanning technology prior to medication administration
- Use of 'smart' infusion pumps with standardised libraries and dose error reduction software to check infusion rates against pre-set limits for each medication.

TRANSFER FROM THE CRITICAL CARE UNIT

- A standardised process for review of medication on discharge from ICU to avoid **ICU medications** being continued inappropriately
- A standardised process for review of medication on discharge from ICU to ensure that **pre-ICU medications** are restarted as appropriate

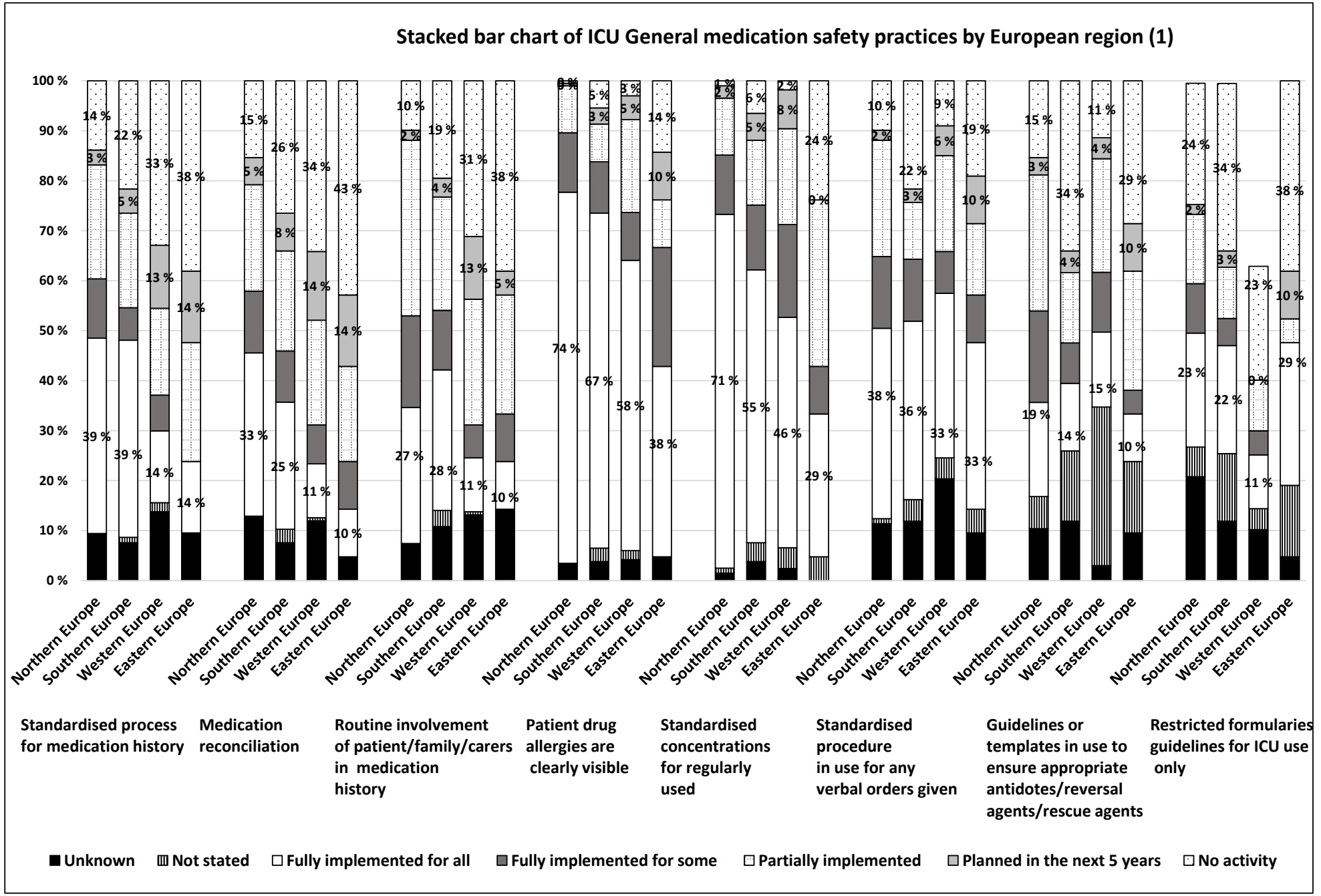
SAFETY CULTURE AND PRACTICES

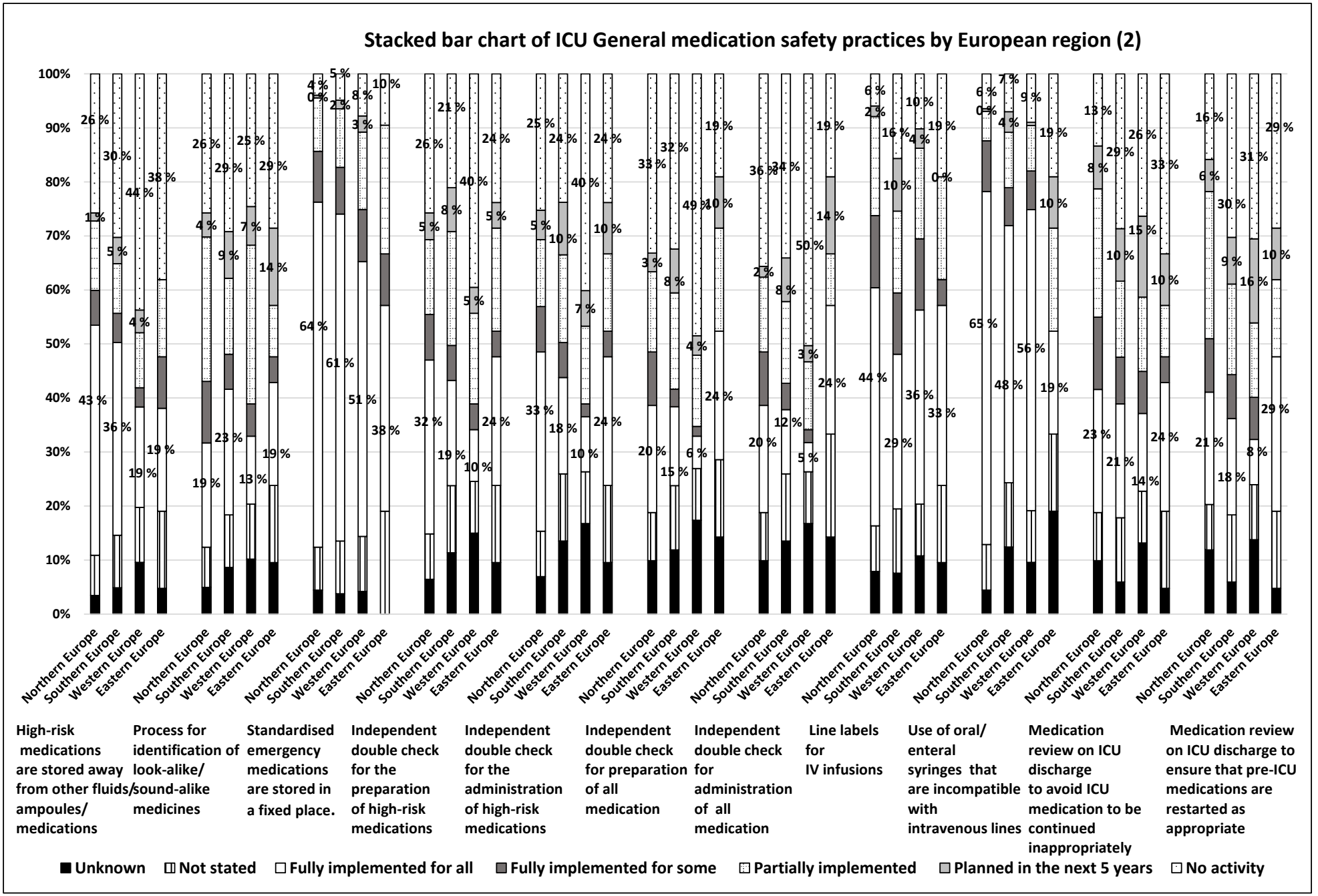
- Use of an **incident reporting** system to learn from medication incidents (both errors and near misses)
- Regular discussion of medication incidents (both errors and near misses) and identification of corrective actions
- Provision of **standardized introduction** to medication-related processes, protocols, instructions, checklists for all new employees (nurses, physicians, and pharmacy staff) in the unit
- Identification of **high-risk medications** that have an increased risk of causing significant patient harm if they are misused (e.g. potassium chloride, inotropes, narcotics, sedatives, insulin, anticoagulants) and use of detailed protocols, guidelines to reduce these risks.
- Regular **medication safety audits** as a part of the unit's quality monitoring.
- A designated **medication safety officer** is available for the hospital organisation

OTHER

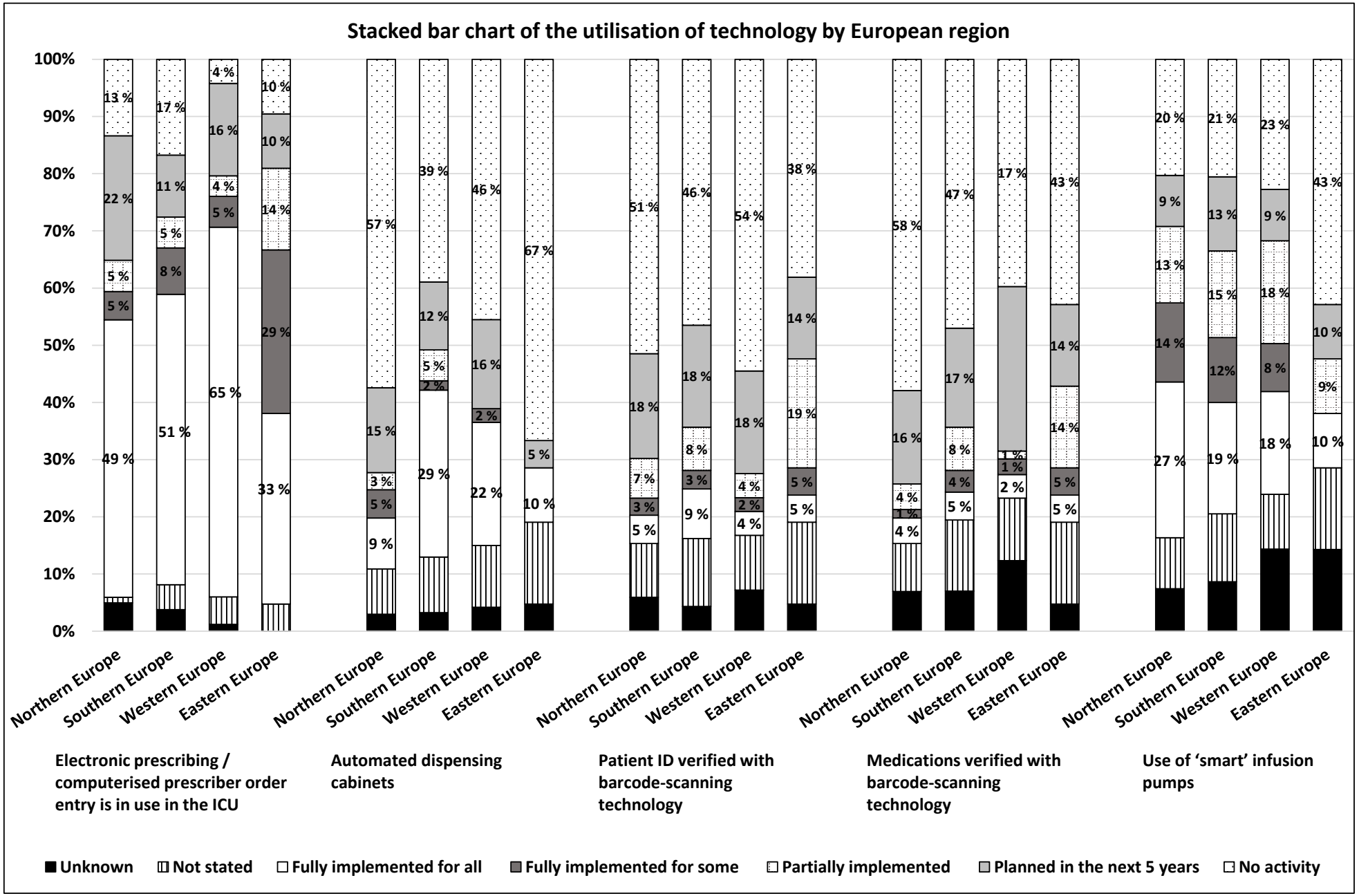
- Other medication safety strategies in use or planned that are not mentioned above: _____(space for free text responses)
- Any other comments_____

Appendix 2 – ICU General medication safety practices by European region

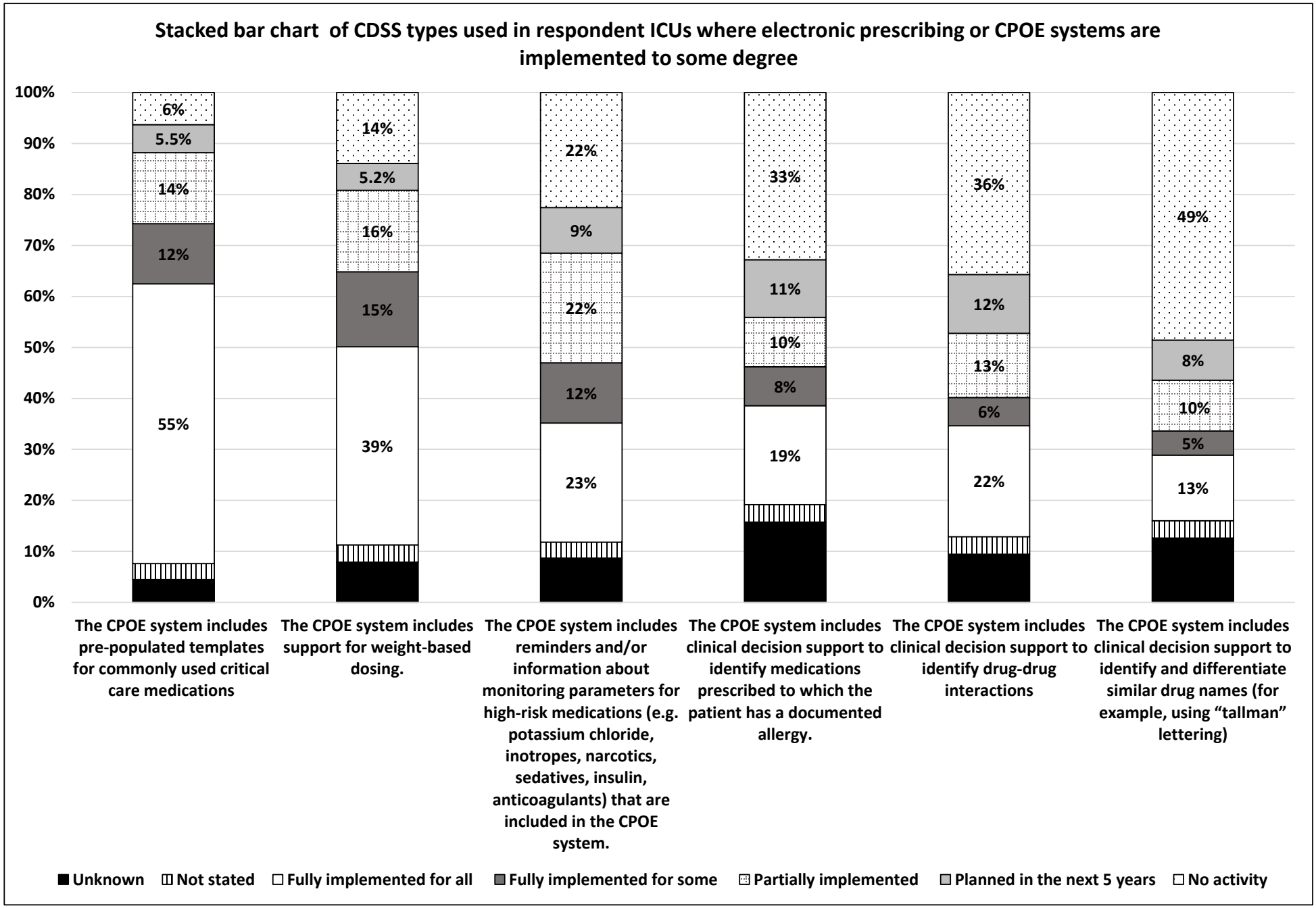



Stacked bar chart of ICU General medication safety practices by European region (2)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Northern Europe
Southern Europe
Western Europe
Eastern Europe
High-risk medications are stored away from other fluids/ ampoules/ medications
Process for identification of look-alike/ sound-alike medicines
Standardised emergency medications are stored in a fixed place.
Independent double check for the preparation of high-risk medications
Independent double check for the administration of high-risk medications
Independent double check for preparation of all medication
Independent double check for administration of all medication
Line labels for IV infusions
Use of oral/ enteral syringes that are incompatible with intravenous lines
Medication review on ICU discharge to avoid ICU medication to be continued inappropriately
Medication review on ICU discharge to ensure that pre-ICU medications are restarted as appropriate
Unknown
Not stated
Fully implemented for all
Fully implemented for some
Partially implemented
Planned in the next 5 years
No activity

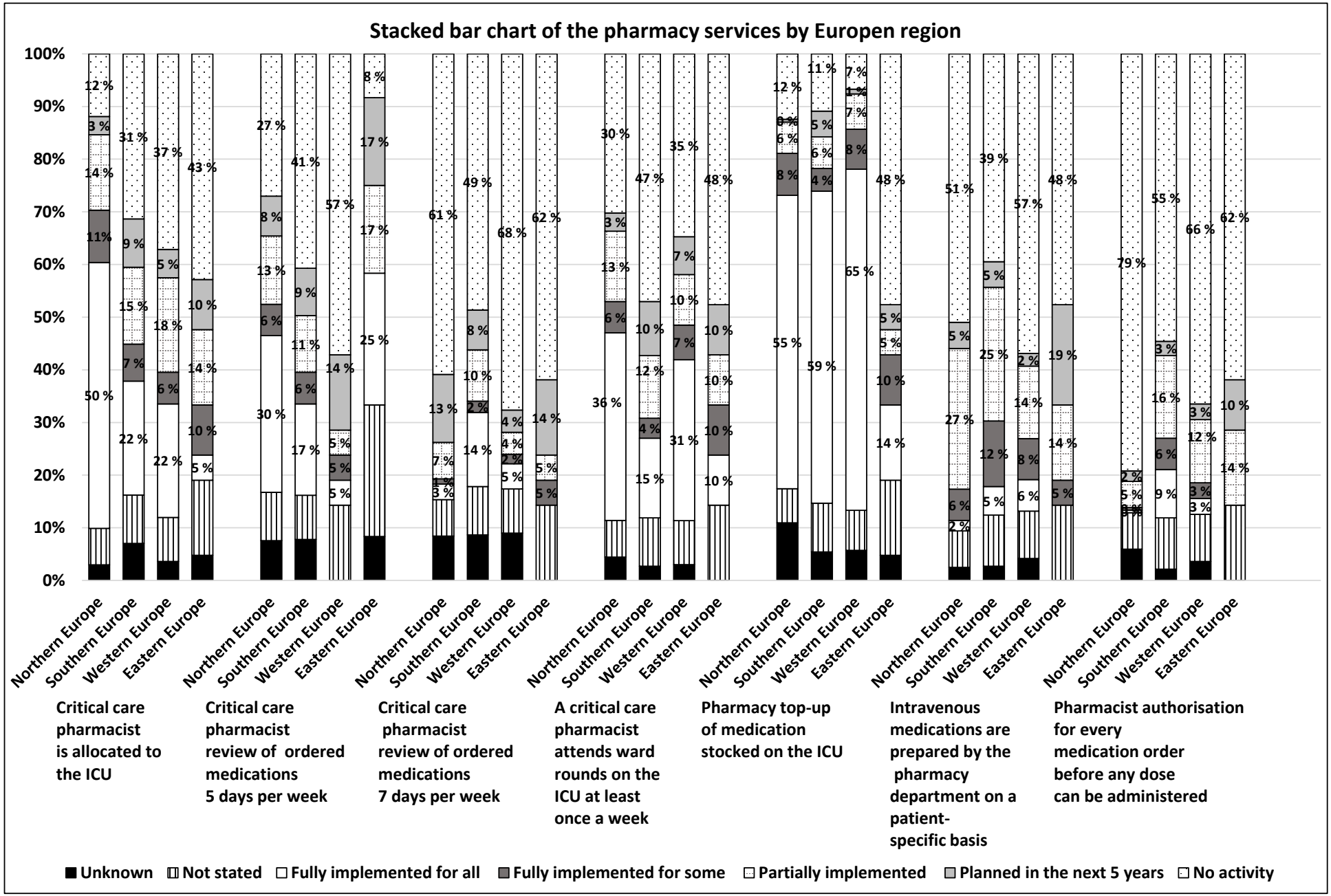
Appendix 3 – Utilisation of technology by European region



Appendix 4 - CDSS types used in respondent ICUs where electronic prescribing or CPOE systems are implemented to some degree



Appendix 5 – Pharmacy services by European region



Appendix 6 – Incident reporting and learning practices by European region