European E-Prescriptions: Benefits and Success Factors

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ABSTRACT

Electronic prescriptions (e-prescriptions) are an important component of digital health systems for the future, promising increased efficiency, better patient safety through error reduction, and increased patient convenience. The topic is high on the agendas of national and EU policymakers, particularly as it forms part of the vision for a single digital market and cross-border healthcare in Europe.

This paper examines the economic, health, and social benefits of e-prescriptions, including their realisation within different time frames of policy implementation. Based on previous evidence and expert interviews for case studies of Estonia, the United Kingdom, Denmark, and Sweden, this research analyses to what extent existing models of e-prescription implementation can determine implications for their wider utilisation across Europe.

The findings confirm some economic benefits, such as efficiency gains for prescribers and dispensers, savings arising from transparency, fraud reduction, and reduced printing costs; health benefits such as reduced medication errors, better accessibility of medicines, increased monitoring of adherence to physician recommendations, and aggregate analysis of health data; and social benefits around patient satisfaction with the health system, financial relief for society, and social care for the elderly.

Whether these benefits are realised, however, depends on the country's baseline system—and above all, on how e-prescriptions are implemented and embedded in sociotechnical systems. The case studies also reveal seven success factors for introducing e-prescriptions and realising their benefits: the maturity of information technology in the health system, thoughtful process and system design, facilitation of standards, strong leadership and stakeholder alignment, incentives and change management, trust and digital readiness among the population and workforce, and the existence of a suitable implementation plan.

Overall, this paper seeks to enhance understanding of the societal value of e-prescriptions and supports their further diffusion in Europe through recommendations for practice and policymaking.

INTRODUCTION

Health systems in Europe and around the world have recognised the transformative potential of digital health services for improving care delivery and reducing costs. Electronic prescriptions (e-prescriptions) are a crucial cornerstone of this new digital health system, because prescribing and dispensing medication is a frequent everyday activity that links various actors in the system.[1] The introduction of e-prescriptions addresses a major cost issue, with pharmaceutical expenditures making up about 20 percent of a country's total health spending on average,[2] while an estimated 30 percent of a country's health budget is spent on handling, collecting, storing, and searching for information.[3]

Beyond the economic aspects, previous research has identified potential health and social benefits of e-prescriptions, such as improving quality of care and patient safety through error reduction,[4] and increasing patient convenience, particularly for repeat prescriptions.[5] At the same time, however, there are debates about whether these benefits are actually achieved and about the extent to which they can in fact be attributed to e-prescriptions across sociotechnical circumstances and different countries.[6] Particularly in the EU context, e-prescriptions form part of the "single digital market" aspiration, as declared by the eHealth Action Plan and the Digital Agenda for Europe, and more specifically the EU Cross Border Health Directive (2011/24/EU, Article 11, 14).

On this backdrop, this paper examines the economic, health, and social benefits of e-prescriptions and discusses whether these benefits can be tied to certain time frames or specific stages of policy implementation. In order to do so, it focuses on four countries as case studies: Estonia, the United Kingdom (UK), Sweden, and Denmark. The national case studies serve as a basis for deriving a set of success factors for the introduction of e-prescriptions, thereby providing a launching point to evaluate the extent to which these national approaches can serve as models for other nations and to draw implications for the wider utilisation of e-prescriptions across Europe.

This paper reviews the existing literature on e-prescriptions, focusing on the country case studies, and systematises the evidence around benefits and success factors. In addition, it supplements these studies through eleven interviews with government representatives and other researchers from Estonia, the UK, Sweden, and Denmark.[7]

The second section presents the current landscape of e-prescriptions in the European Union as a background to the discussion and introduces the four country case studies examined in this research. The third section then discusses the economic, health, and social benefits identified based on previous research and interviews. The fourth section focuses on success factors for introducing e-prescriptions across the four country case studies. The fifth section concludes with an analysis of whether the national approaches discussed can serve as models for other EU countries.

BACKGROUND: THE LANDSCAPE OF E-PRESCRIPTIONS IN THE EUROPEAN UNION

With the growing penetration of computers in the health system, doctors have increasingly moved from handwritten to electronic prescriptions.[8] Prescription software was introduced for computerised physician

1   Toy Cornford, Ralph Hibberd, and Nick Barber, "The Evaluation of the Electronic Prescription Service in Primary Care," *Final Report on the Findings from the Evaluation in Early Implementer Sites*, School of Pharmacy, University of Nottingham, London School of Economics and Political Science (January 2014).

2   Organisation for Economic Cooperation and Development (OECD), "Health at a Glance 2015: OECD Indicators" (Paris: OECD Publishing, November 2015).

3   Health Information and Quality Authority (HIQA), "E-Prescribing and Electronic Transfer of Prescriptions: An International Review," Report, December 2012.

4   Abha Agrawal, "Medication Errors: Prevention Using Information Technology Systems," *British Journal of Clinical Pharmacology*, Vol. 67, No. 6 (June 2009), pp. 681–686; Marianne Lisby, Lars Peter Nielsen, and Jan Mainz, "Errors in the Medication Process: Frequency, Type, and Potential Clinical Consequences," *International Journal for Quality in Health Care*, Vol. 17, No. 1 (January 2005), pp. 15–22.

5   Terry Porteous, Christine Bond, Roma Robertson, Philip Hannaford, and Ehud Reiter, "Electronic Transfer of Prescription-related Information: Comparing Views of Patients, General Practitioners, and Pharmacists," *British Journal of General Practice*, Vol. 53, No. 488 (March 2003), pp. 204–209; Tora Hammar, Sofie Nyström, Göran Petersson, Bengt Åstrand, and Tony Rydberg, "Patients Satisfied with E-Prescribing in Sweden: A Survey of a Nationwide Implementation," *Journal of Pharmaceutical Health Services Research*, Vol. 2, No. 2 (March 2011), pp. 97–105.

6   Nick Barber, Bryony Dean Franklin, Tony Cornford, Ela Klecun, and Imogen Savage, "Safer, Faster, Better? Evaluating Electronic Prescribing," *Report to the Patient Safety Research Programme*, Policy Research Programme of the Department of Health, United Kingdom (November 2006); Cornford et al., "The Evaluation of the Electronic Prescription Service in Primary Care."

7   All interviewees were selected based on their expertise in the area of e-prescriptions and interviewed via telephone or Skype during March – April 2016. All interviewees expressed their personal views, which should not necessarily be interpreted as reflecting the official position of their respective organisations.

8   Gunnar O. Klein, "History of Electronic Prescriptions in Sweden: From Time-Sharing Systems via Smartcards to EDI," in *History of Nordic Computing 3* (Berlin: Springer, 2010), pp. 65–73.

orders, and over time became more sophisticated by incorporating patients' prescription histories and clinical decision support, for example, for detecting drug interactions. At the same time, barcodes enabled dispensers to read prescriptions without rekeying information. With the Internet forming an integral part of the health system, the requirements for printing and physically taking prescriptions to pharmacies have disappeared; they have been replaced by interconnected networks of prescribers and dispensers.

Based on the last stage of this evolution, this paper defines "e-prescriptions" as the ability of a prescriber (usually a doctor in a practice or hospital) to generate a prescription electronically, which is then sent via an interconnected network to a dispenser (usually a pharmacy or dispensing appliance contractor) for the patient to obtain the prescribed product.[9] Figure 1 presents a simplified conceptualisation of this definition in the context of primary care. It also shows that patients do not necessarily need electronic devices to use e-prescriptions, although they can often access their prescriptions through patient portals. This definition decouples e-prescriptions from related but separate aspects, such as digital inclusion, addressed in several countries' digital health strategies.[10]

Figure 1: Simplified Overview of E-Prescriptions in Primary Care.
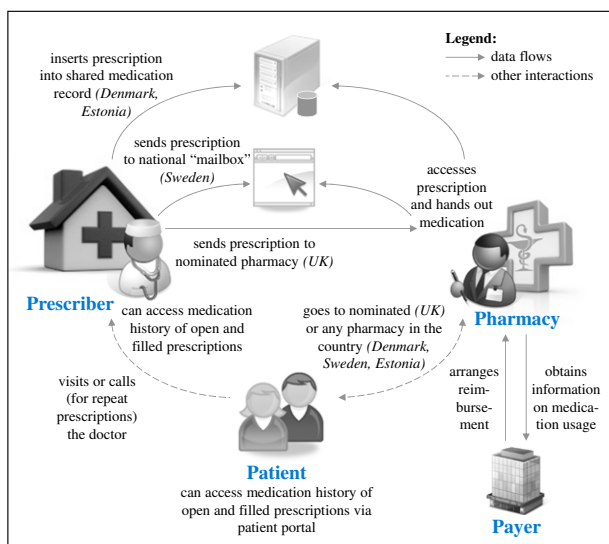
E-prescriptions exist both in primary care (dispensing of community pharmacies to patients) and secondary care (dispensing of hospitals to patients within the hospital and to community pharmacies). This paper focuses primarily on the former in all its case studies, but draws on insights from the hospital area where appropriate. Across care settings, e-prescriptions may be connected to other data sources such as Electronic Medical Records (EMR), which include all medical data about a patient, often in rich detail and unstructured formats, or claims data used for payment purposes, which has less detail but a high degree of structure.

Within the European Union, nationwide e-prescription initiatives are on the rise in several countries, including Estonia, the UK (England, Scotland, Wales, and Northern Ireland), Sweden, and Denmark, as detailed in this paper. In addition, apart from numerous local and regional initiatives, there are national initiatives in Finland, the Netherlands, Belgium, and Spain[11] to facilitate the electronic exchange of prescription data.[12] E-prescriptions are also part of digital health strategies across the globe, including in Australia, New Zealand, the United States, and Canada.

Beyond single countries, e-prescriptions have been declared a policy priority in the eHealth Action Plan and the Digital Agenda for Europe in order to improve cross-border data exchange across the European Union. Complex scenarios have been developed for patients from one country obtaining e-prescriptions in a second, and having it dispensed in a third. But because healthcare is generally the responsibility of the EU member states, each country is free to decide on its own plans without a central mandate.[13] Consequently, cross-border e-prescriptions rely foremost on national infrastructures.

9   Patrick Kierkegaard, "E-Prescription across Europe," *Health and Technology*, Vol. 3, No. 3 (December 2013), pp. 205–219; and HIQA, "E-Prescribing and Electronic Transfer of Prescriptions: An International Review."

10   UK Government, "Government Digital Strategy," December 2013, https://www.gov.uk/government/publications/government-digital-strategy/government-digital-strategy, accessed 29 April 2016.

11   Hannele Hyppönen, Pirkko Nykänen, Lauri Salmivalli, Marja Pajukoski, Pekka Ruotsalainen, and Suvi Vuorela, "Conducting Interdisciplinary Research: Evaluation of the E-Prescription Pilot Scheme in Finland." *Electronic Journal of Information Systems Evaluation*, Vol. 8, No. 3 (November 2005), pp. 187–194; Lidia Villalba van Dijk, Han De Vries, and Douglas S. Bell, "Electronic Prescribing in the United Kingdom and in the Netherlands," RAND Europe, February 2011; Ieren Lizano-Díez, Pilar Modamio, Pilar López-Calahorra, Cecilia F. Lastra, Jose L. Segú, Antoni Gilabert-Perramon, and Eduardo L. Mariño, "Evaluation of Electronic Prescription Implementation in Polymedicated Users of Catalonia, Spain: A Population-based Longitudinal Study," *BMJ Open*, Vol. 4, No. 11 (November 2014), e006177; Mia Mäkinen, Päivi Rautava, Jari Forsström, and Markku Äärimaa, "Electronic Prescriptions are Slowly Spreading in the European Union," *Telemedicine and e-Health*, Vol. 17, No. 3 (April 2011), pp. 217–222.

12   World Health Organization (WHO), "From Innovation to Implementation: E-Health in the WHO European Region," Report, Copenhagen, Denmark, March 2016.

13   Mäkinen et al., "Electronic Prescriptions are Slowly Spreading in the European Union."

Technical foundations for data exchange within the European Union were laid as part of the European Patient Smart Open Services (epSOS) project, which began in 2008. The project was intended to build an underlying service infrastructure as the basis for e-prescriptions and other health services,[14] with the ongoing EXPAND project helping to deploy these developments across EU nations. One of the project's results is the definition of a common minimum dataset, with twenty-five and seventeen European countries participating in epSOS and EXPAND respectively. The Connecting Europe Facility initiative provides funds to member states for implementing various electronic services, including e-prescriptions.[15]

Technical interoperability is not sufficient, however. EU countries have different prerequisites in terms of their care policies, data protection laws, and privacy enforcement,[16] all of which are important, because electronic services may raise privacy and security concerns.[17] Benefits will also differ across countries, because the effectiveness of e-prescribing depends on the institutional context in which it is embedded.[18] Finally, implementation approaches may have to vary by country, because they may be driven partially by country size (and the associated complexity) and structural features of the health system in terms of providers, pharmacies, and payers.

Consequently, the specific cases of Estonia, the UK, Sweden, and Denmark help to illustrate the different contexts in which e-prescriptions have been introduced. These countries share a common feature: they have all implemented e-prescriptions. They are, however, at different stages of e-prescription maturity, cover the continuum of very small to larger countries, and possess different features in terms of their general penetration of e-services and structures in the health system. Table 1 presents an overview of all four countries, followed by a detailed introduction of each below.

Table 1: Overview of Country Case Studies.

	Estonia	United Kingdom	Sweden	Denmark
Overview of e-prescriptions				
E-prescription coverage *(of total prescriptions)*	>99%	43% in primary care, lower in secondary care	>90%	>99% (although not counted as e-prescription messages anymore since 2014)
Introduction of e-prescriptions	2010	Primary care: 2005 (Release 1), 2012 (Release 2)	Began in 1983, central introduction in 2000	1992
Structural features				
Inhabitants	1.3 million	64.1 million	9.5 million	5.6 million
Payer	Single public payer	Single public payer	Single public payer	Single public payer
Provider	Private	Largely public	Private and public	Largely public
Pharmacies	Private	Largely private	Single public pharmacy chain (before 2009), now private	Private
Implementation strategy				
Rollout approach	"Big bang"	Decentralised rollout based on individual choice	Pilot in Stockholm, then regional rollout	Gradual rollout alongside general computerisation of health system
Functionalities	All functionalities in principle available from the beginning	Primary care: phased introduction in two major releases, Secondary care: decentral approach	Some functionalities (e.g., central mailbox) added over time	Some functionalities (e.g., shared medication database) added over time

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14 HIQA, "E-Prescribing and Electronic Transfer of Prescriptions: An International Review."

15 European Commission, "Connecting Europe Facility," March 2016, https://ec.europa.eu/digital-single-market/en/connecting-europe-facility, accessed 22 March 2016.

16 Kierkegaard, "E-Prescription across Europe."

17 Yanjiang Yang, Xiaoxi Han, Feng Bao, and Robert H. Deng, "A Smart-Card-Enabled Privacy Preserving E-Prescription System,"

IEEE Transactions on Information Technology in Biomedicine, Vol. 8, No. 1 (March 2004), pp. 47–58; Dong, Naipeng, Hugo Jonker, and Jun Pang, "Challenges in eHealth: From Enabling to Enforcing Privacy," in *Foundations of Health Informatics Engineering and Systems* (Berlin: Springer, 2011), pp. 195–206.

18 Barber et al., "Safer, Faster, Better? Evaluating Electronic Prescribing"; Cornford et al., "The Evaluation of the Electronic Prescription Service in Primary Care."

Estonia

Estonia, with 1.3 million inhabitants, is known for its cutting-edge approach to digitisation. The country began to chart a digital path after regaining independence (from the Soviet Union) in 1991; the process escalated with the rollout of a wide range of e-government services at the turn of the millennium. This includes well-linked services around tax filing, digital signatures, and a universal electronic identification document (eID) card, which are enabled by the nationwide backbone X-Road, an e-services architecture that allows for adding new services easily.[19] Consequently, the digital domain is closely intertwined with the nation more broadly, e-government services are widely adopted by enterprises and individuals, and digital readiness in the population is considered high.[20]

In line with many European countries, the Estonian health system is founded on solidarity, with a single public payer, the Estonian Health Insurance Fund (EHIF), providing mandatory health insurance for nearly all of the population.[21] Based on Estonia's Health Information System Act (2007) and the Government Regulatory Act of Health Information Exchange (2008), EMRs were introduced in 2008, followed by a nationwide e-prescription system with a "big bang approach" in 2010.[22] Since then, the digital service has grown rapidly: 84 percent of prescriptions in the country were issued electronically in 2011, 95 percent in 2013, and over 99 percent today.[23]

The Estonian e-prescription system enables data exchange between patients, providers, pharmacies, and the EHIF. To issue a prescription, the provider creates an entry in a patient's shared medication record, based on which patients can obtain their medication in any pharmacy in the country based on their eID. Patients can also log in via an online portal and view the audit trail of data access and use.[24] Patient consent is not required, although an opt-out mechanism allows patients to restrict data access either completely or partially.[25]

The United Kingdom

For its 64.1 million inhabitants, the UK has a National Health Service (NHS) financed through general taxation and free at the point of care, which is separately managed for its constituent countries (England, Wales, Scotland, and Northern Ireland). The National Programme for Information Technology (NPfIT) was a major initiative aimed at introducing a central EMR and further digital services in the health system. While the overall programme has not been completed due to major cost overruns, it introduced the so-called Spine as the central backbone of the country's health infrastructure. Digital services in health and other areas of government form part of the UK government's "digital by default" vision to increase service levels and reduce costs in the long term.[26]

In the UK, large differences for e-prescriptions exist between primary and secondary care.[27] In primary care, e-prescriptions are becoming relatively well established. They have been introduced in two releases: the first release (introduced in 2005 with a pilot, followed by nationwide deployment) was not paperless yet; the main changes were a barcode printed on the prescription, which could be scanned by the dispensing pharmacy.[28] Starting in 2012,[29] the second release also enabled electronic transmission, but patients need to nominate a specific pharmacy to which their e-prescription is sent (in contrast to all other case studies). The second release has been implemented by 99 percent of community pharmacies.[30] But only 79 percent of General

19   WHO, "From Innovation to Implementation: E-Health in the WHO European Region."

20   Estonian Ministry of Foreign Affairs, "Estonia's Position in International Rankings 2014–2015," http://www.vm.ee/en/estonias-position-international-rankings-2014-2015, accessed 3 March 3 2016.

21   World Bank Group, "The State of Health Care Integration in Estonia," Summary Report (January 2015).

22   WHO, "From Innovation to Implementation: E-Health in the WHO European Region."

23   Estonian Health Insurance Fund (EHIF), "Digital Prescription," https://www.haigekassa.ee/en/digital-prescription, accessed 29 February 2016; and E-Estonia.com, "E-Prescription," https://e-estonia.com/component/e-prescription, accessed 29 February 2016.

24   Ibid.

25   WHO, "From Innovation to Implementation: E-Health in the WHO European Region."

26   UK Government, "Government Digital Strategy."

27   Tony Cornford, Bryony Dean Franklin, Imogen Savage, Nick Barber, and Yogini H. Jani, "Electronic Prescribing in Hospitals—Challenges and Lessons Learned," Report for NHS Connecting for Health, United Kingdom (June 2009); Zamzam Ahmed, Sara Garfield, Yogini Jani, Seetal Jheeta, and Bryony Dean Franklin, "Impact of Electronic Prescribing on Patient Safety in Hospitals—a Review of Reviews with a Focus on the UK Implications," Clinical Pharmacist (forthcoming).

28   HIQA, "E-Prescribing and Electronic Transfer of Prescriptions: An International Review."

29   Health and Social Care Information Centre (HSCIC), "Statistics and Progress," United Kingdom, http://systems.hscic.gov.uk/eps/stats, accessed 27 April 2016. Longitudinal data presented in this paper was obtained through a request to the HSCIC's Electronic Prescription Service team on 15 December 2015 and received 23 February 2016.

30   Ibid.

Practitioners (GP) have done so,[31] although nearly all GP practices were computerised by 2000.[32] As of April 2016, about 43 percent of prescriptions are transmitted electronically.[33]

In secondary care, e-prescription systems are largely implemented in a decentralised manner based on initiatives of specific hospitals, because plans for a central introduction were abandoned after the demise of the NPfIT in 2010. Consequently, adoption of e-prescribing is even lower: for acute care trusts, more than 50 percent do between 80–100 percent of discharge prescriptions digitally, more than 20 percent also do so for their inpatient prescriptions, whereas less than 10 percent create their outpatient prescriptions digitally.[34] As the interviews evidenced, however, electronic discharge prescriptions are often not transmitted electronically, diverging from the e-prescription definition in this research. The aim of the UK is to digitise hospitals and other aspects of the health system fully by 2020.[35]

Sweden

Sweden, with a population of about 9.5 million people, has a long history of the use of information technology in healthcare. It became one of the first countries to use e-prescriptions when, in 1983, a few doctors connected to local pharmacies to exchange prescriptions.[36] The national effort to improve connectivity in the health system began in 2000, when common standards for health data exchange were introduced.[37] The functionalities were extended over time: based on a national mailbox introduced in 2004, patients could get their medication dispensed at any pharmacy, and access their prescriptions via an online portal.

A particular circumstance in Sweden is that there was only a single pharmacy chain (Apoteket AB) when e-prescriptions were introduced. This state-owned pharmacy implemented e-prescriptions together with the Stockholm County Council, initially focusing on the region around the capital. From there onward, it was rolled out throughout the country while ensuring interoperability, given that Sweden's healthcare is organised at the regional level.[38] The organisational responsibility for e-prescriptions lies with the Swedish eHealth authority.

The share of prescriptions transmitted electronically rose continually over the last decade: there were about 3 million e-prescriptions in 2002 and 25 million e-prescriptions (75 percent of prescriptions) in 2007,[39] while in 2014, about 90 percent of the prescriptions were sent electronically.[40] Patients generally expressed high satisfaction with the system, with positive general attitudes for 85 percent of the population, and positive views regarding the safety (79 percent) and benefits (78 percent) of e-prescriptions.[41]

Denmark

Denmark, with a population of 5.6 million, also has a central public health system with the Ministry of Interior and Health at its core. Like Sweden, the country belongs to the early adopters of health information technology and may be seen among the leading countries.[42] Danish citizens can use an online portal to access their health data and communicate with health providers. E-prescriptions began in Denmark in 1994, with the central eHealth organisation Medcom driving stakeholder alignment and setting up the necessary standards for e-prescriptions.

Although no staged approach was chosen, the service started slowly, with about 4,000 exchanged messages in the first year.[43] The main driver for growth over the following two decades was the computerisation of the health system. Due to the early introduction of e-prescriptions, all basic functionalities (a central medication database and further common standards) were implemented into software packages of various vendors from the outset.

31 Ibid.
32 Villalba van Dijk et al., "Electronic Prescribing in the United Kingdom and in the Netherlands."
33 HSCIC, "Statistics and progress."
34 An Slee, "High Quality Care Now, For All Now and For Future Generations," Presentation, April 2016.
35 National Information Board (NIB), "Personalised Health and Care 2020. Using Data and Technology to Transform Outcomes for Patients and Citizens," Framework for Action, United Kingdom, November 2014.
36 Bengt Åstrand, Emelie Montelius, Göran Petersson, and Anders Ekedahl, "Assessment of E-Prescription Quality: an Observational Study at Three Mail-Order Pharmacies," *BMC Medical Informatics and Decision Making*, Vol. 9, No. 1 (January 2009), pp. 1–8.
37 Klein, "History of Electronic Prescriptions in Sweden: From Time-Sharing Systems via Smartcards to EDI."

38 epSOS, "Country profile: Sweden," http://www.epsos.eu/home/project-members-beneficiaries/participating-nations/sweden.html, accessed 29 February 2016.
39 HIQA, "E-Prescribing and Electronic Transfer of Prescriptions: An International Review."
40 Vardgivarguiden, "E-Prescriptions in Sweden," http://www.vardgivarguiden.se/avtaluppdrag/it-stod-och-e-tjanster/e-tjanster-och-system-a-o/beslutsstod/e-recept/e-prescriptions-in-sweden, accessed 22 April 2016.
41 Hammar et al., "Patients Satisfied with E-Prescribing in Sweden: a Survey of a Nationwide Implementation."
42 Kierkegaard, "E-Prescription across Europe."
43 Ib Johansen, "E-Prescriptions, ETP – Denmark," June 2004, https://www.ehtel.eu/activities/tasks-sources/tf-patient-safety-emedication/ehtel-seminar-eprescribing-an-overview-of-challenges-and-experiences-in-europe-amsterdam-2004/files/dk_ib-johansen_2004.pdf, accessed 22 March 2016.
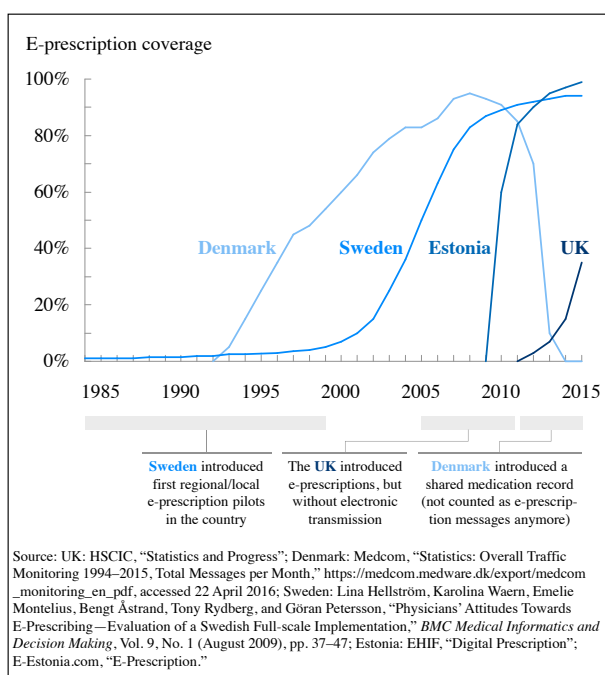
In 2010, about 88 percent of all prescriptions were sent electronically in Denmark;[44] as of 2016, there are virtually no paper-based prescriptions anymore.

Until 2014, Danish doctors could either send e-prescriptions to specific pharmacies, so that they could be prepared accordingly, or submit an open e-prescription, so that patients could go to any pharmacy in the country. The approach was then changed to a shared medication record (called FMK), with mandatory use across care settings. Prescribers now enter the prescription information directly into the database, which pharmacies access for dispensing medication, while other providers can use it to view the patient's medication.

* * *

To summarise, Estonia, the UK, Sweden, and Denmark introduced e-prescriptions at different points in time based on different prerequisites in terms of their general country size, the features of their health system, and digital maturity of the health system and the country more generally. As a result of these different histories, uptake patterns varied considerably (see Figure 2). This variation is important: it will help to contextualise the benefits of e-prescriptions and will enable the drawing of conclusions about the success factors involved in the introduction of e-prescriptions generally.

Figure 2: Uptake Patterns of E-Prescriptions.

Source: UK: HSCIC, "Statistics and Progress"; Denmark: Medcom, "Statistics: Overall Traffic Monitoring 1994–2015, Total Messages per Month," https://medcom.medware.dk/export/medcom _monitoring_en_pdf, accessed 22 April 2016; Sweden: Lina Hellström, Karolina Waern, Emelie Montelius, Bengt Åstrand, Tony Rydberg, and Göran Petersson, "Physicians' Attitudes Towards E-Prescribing—Evaluation of a Swedish Full-scale Implementation," *BMC Medical Informatics and Decision Making*, Vol. 9, No. 1 (August 2009), pp. 37–47; Estonia: EHIF, "Digital Prescription"; E-Estonia.com, "E-Prescription."

ECONOMIC, HEALTH, AND SOCIAL BENEFITS OF E-PRESCRIPTIONS

E-prescriptions may have various closely interrelated benefits: economic benefits relating to the improvement of efficiency in the health system, health benefits in terms of providing better patient care, and social benefits for individuals and society more generally. These categories of benefits are not mutually exclusive, with health benefits also leading to substantial economic benefits, for example.[45] Analysing these benefits is important not only for evaluating e-prescriptions, but also because prospective benefits may drive their adoption. This section synthesises the available evidence, largely building on the four country case studies, but drawing on evidence from elsewhere where appropriate.

As this section argues, the evidence is mixed for most benefit levers, which may be attributed to three major sources. First, the benefit may depend on the specific system, and how well the processes are designed. Second, benefits are determined by how well the system worked before: for example, in the United States, transcribing prescriptions by nurses and clerks was a large source of error, so e-prescriptions had a substantially larger impact there than in the UK.[46] Finally, and related to the other aspects, evidence either stems from single-site evaluations or large-scale economic models, which suffer from limited generalisability or only use best-case scenarios.[47]

Economic Benefits

A first cluster of economic benefits occurs around the **efficiency gains for prescribers,** particularly for repeat prescriptions. In Sweden, physicians estimate that e-prescriptions save about 30 minutes daily,[48] and 91 percent of physicians agreed that e-prescriptions helped them to save time compared to hand-written prescriptions.[49] Similarly, a survey in Estonia also supported perceived time savings, with repeat

44 HIQA, "E-Prescribing and Electronic Transfer of Prescriptions: An International Review"; Kierkegaard, "E-Prescription across Europe."

45 Statista.de, "Vermeidbare Kosten im deutschen Gesundheitswesen im Jahr 2013 (Avoidable costs in the German health system in 2013)", http://de.statista.com/statistik/daten/studie/283861/ umfrage/gesundheitswesen–vermeidbare–kosten–in– deutschland–2013/, accessed 23 May 2016.

46 Barber et al., "Safer, Faster, Better? Evaluating Electronic Prescribing."

47 Agrawal, "Medication Errors: Prevention Using Information Technology Systems."

48 HIQA, "E-Prescribing and Electronic Transfer of Prescriptions: An International Review."

49 Hellström et al., "Physicians' Attitudes towards E-Prescribing— Evaluation of a Swedish Full-scale Implementation."

prescriptions now taking about 10–15 seconds, and new prescriptions taking about 30–60 seconds.[50] Also, in the UK, time savings from electronic repeat prescriptions were among the top advantages of e-prescriptions—although views differed on whether actual physician time was saved.[51] In addition to the prescription process itself, time may also be saved as e-prescriptions facilitate obtaining patients' comorbidities and other medications, which prescribers need to know before handing out prescriptions (as the next section on health benefits will also discuss).

Bengt Åstrand, pharmacist from Linnaeus University in Kalmar, Sweden, and project manager when the first e-prescription in the world was exchanged in Sweden in 1983, asked: "Do we save physicians' time today compared to what we did 15 years ago? It's very hard to show that really."[52] A UK-based evaluation showed that time savings depended on the specific GP practice: while for most practices it was faster to sign the e-prescriptions, some signed the paper-based version more quickly.[53] In studies of specific hospitals, time spent on drug administration rounds decreased from 50 to 40 minutes, but increased for single prescriptions (20 to 55 and 15 to 39 seconds respectively) and medication tasks outside of drug rounds.[54] In line with this, a meta-review of UK-based studies also reported mixed evidence for actual time savings.[55] General reasons for the difficulty of measuring efficiency gains from information technology are measurement errors due to using conventional methods, time lags between

costs and benefits, redistribution rather than elimination of steps, and a lack of explicit measures of the value of the system.[56] In addition, it is questionable whether the chunks of time saved are used for value-creating activities.

Further efficiency gains may also come from reducing the need for certain procedures altogether, as Ain Aaviksoo (Deputy Secretary General for E-services and Innovation at Ministry of Social Affairs, Estonia) illustrated in the context of assessments for obtaining government benefits for limited working capacity. Instead of physical checkups, "the system has been designed that some assessments can be done based on the earlier medical history. […] Combining data about medical conditions and the drugs that a patient takes, it is possible to assess the status of someone's health with much higher accuracy."[57] Of course, a reduction in health service use will only be achieved if physicians' incentives are addressed accordingly, by capitation or pay-for-performance based systems, for example, rather than fee-for-service models.[58]

Similarly, there may be **efficiency gains for dispensers**, such as lower workload for staff, better stock management, and reduced volumes of paper to be sorted at the end of the month for reimbursement.[59] In addition, if pharmacies are sent specific prescriptions, they may better balance the workload by preparing orders before patients arrive. In Sweden, where pharmacists' satisfaction rates with e-prescriptions are at 98 percent, free-text answers about benefits of e-prescriptions included time savings for 55 percent of pharmacists.[60] Then again, in the UK, pharmacists explained that downloading a prescription from the Spine could take up to 30 seconds,[61] and that they were not allowed to check frequently for new prescriptions from their nominees.[62] Further evaluations of efficiency gains in pharmacies are currently still being conducted.[63]

50 Tarmo Kalvet, Marek Tiits, and Hille Hinsberg, "E-Teenuste kasutamise tulemuslikkus ja mõju (The Effectiveness and Impact of Estonian E-services)" (Tartu, Estonia: Institute of Baltic Studies, 2013), http://www.praxis.ee/fileadmin/tarmo/Projektid/Valitsemine_ja_kodanike%C3%BChiskond/E-teenuste_kasutamise_tulemuslikkus_ja_moju.pdf, accessed 15 April 2016, as cited in Liisa Parv, Priit Kruus, Kaie Mõtte, and Peeter Ross, "An Evaluation of E-Prescribing at a National Level," Informatics for Health and Social Care, Vol. 41, No. 1 (January 2016), pp. 78–95.

51 Charles P. Schade, Frank M. Sullivan, Simon De Lusignan, and Jean Madeley, "e-Prescribing, Efficiency, Quality: Lessons from the Computerization of UK Family Practice," Journal of the American Medical Informatics Association, Vol. 13, No. 5 (September 2006), pp. 470–475.

52 Author interview.

53 Cornford et al., "The Evaluation of the Electronic Prescription Service in Primary Care."

54 K. Diane Evans, Stuart W. Benham, and Christopher S. Garrard, "A Comparison of Handwritten and Computer-assisted Prescriptions in an Intensive Care Unit," Critical Care, Vol. 2, No. 2 (May 1998), pp. 73–80; and Bryony Dean Franklin, Kara O'Grady, Parastou Donyai, Ann Jacklin, and Nick Barber, "The Impact of a Closed-loop Electronic Prescribing and Administration System on Prescribing Errors, Administration Errors and Staff Time: a Before-and-After Study," Quality and Safety in Health Care, Vol. 16, No. 4 (January 2007), pp. 279–284.

55 Ahmed et al., "Impact of Electronic Prescribing on Patient Safety in Hospitals—a Review of Reviews with a Focus on the UK Implications."

56 Erik Brynjolfsson, "The productivity paradox of information technology," Communications of the ACM, Vol. 36, No. 12 (December 1993), pp. 66–77.

57 Author interview.

58 Villalba van Dijk et al., "Electronic Prescribing in the United Kingdom and in the Netherlands."

59 HIQA, "E-Prescribing and Electronic Transfer of Prescriptions: An International Review."

60 Tora Hammar, Sofie Nyström, Göran Petersson, Tony Rydberg, and Bengt Åstrand, "Swedish Pharmacists Value E-Prescribing: a Survey of a Nationwide Implementation," Journal of Pharmaceutical Health Services Research, Vol. 1, No. 1 (March 2010), pp. 23–32.

61 Villalba van Dijk et al., "Electronic Prescribing in the United Kingdom and in the Netherlands."

62 Cornford et al., "The Evaluation of the Electronic Prescription Service in Primary Care."

63 Behnaz Schofield, Kathrin Cresswell, Johanna Westbrook, Ann Slee, Alan Girling, Sonal Shah, Jamie Coleman, and Aziz Sheikh, "The Impact of Electronic Prescribing Systems on Pharmacists' Time and

In addition, e-prescriptions may also reduce the need for call-backs between prescribers and dispensers due to legible and complete information (e.g., verified by rules engines), saving time on both sides. In early UK studies, electronically capturing repeat prescriptions instead of hand-written prescriptions reduced pharmacy call-backs from 6 percent to 1 percent.[64] Then again, in Sweden, a review of more than 30,000 prescriptions showed that clarification contacts were necessary for 2 percent of e-prescriptions (largely about dosage-related questions), but only 1.2 percent of paper-based prescriptions.[65] In addition, pharmacists are an important safety net for screening prescriptions,[66] so there will always be some problems to be resolved.[67]

Third, economic benefits also stem from e-prescriptions as **enablers of transparency**, which makes doctors more accountable for what they prescribe. This allows for evaluating adherence to clinical guidelines (unless medical circumstances justify deviations from them), which, beyond economic benefits, may also have health benefits. In addition, transparency also sheds light on which medication pharmacies dispense, and how quickly they do so—repeated delays in hospital pharmacies, for example, may be tracked and used as a basis for supply chain negotiations.

Increased transparency has also helped to enforce cost-saving initiatives: in Estonia, for example, e-prescriptions enabled shifting from prescribing branded drugs to active ingredients. As Aaviksoo explained: "The system was designed in such a way that the default choice for physicians was not the brand name, but rather the active ingredient. If they wanted to add a brand name, they needed extra effort, and also needed to justify that. So it was a two-step barrier."[68] Helen Hoyer, Programme Manager at the EHIF, confirmed that this led to a share of prescriptions by active ingredients from less than 50

percent to about 90 percent.[69] This reduced patients' out-of-pocket costs by about 25 percent, according to Aaviksoo, although pharmaceutical expenditures on the payer side were not reduced overall.[70] A similar rationale was applied in Denmark, where prescribers have to choose the cheapest generic brand, unless required otherwise due to medical circumstances.

Fourth, **fraud reduction** is also an economic benefit. With false prescriptions becoming a growing problem across countries,[71] e-prescriptions can alleviate the problem due to the provision of audit trails, the creation of hurdles for filling prescriptions at multiple locations (and obtaining prescriptions from multiple doctors in the first place) and faster analysis of fraud and abuse detection.[72] In the case of Estonia, Hoyer recounted a case in which e-prescriptions revealed that single doctors misused their entitlement of prescribing pharmaceuticals to obtain psychotropic drugs in collaboration with criminal groups. The magnitude of the problem, however, was assumed to be rather small in the Estonian context, so that the associated benefit that e-prescriptions enabled was rather minor in this specific context.

Finally, there are more direct economic benefits with respect to **printing costs**. In Estonia, printing costs for paper prescriptions went down from €63,668 in 2009 to around €1,000 in 2010.[73] As Aaviksoo outlined, the break-even point for the country's investment was nearly achieved "by mere reduction of paper used: the paper forms, printing and storing them securely—so the cost of the system and the maintenance currently is cheaper than if we bought the paper prescriptions."[74] Then again, evaluations in the UK showed that paper usage was potentially increased with the second release of e-prescriptions in primary care, both because physicians printed physical copies of prescriptions for patients who requested them, and because pharmacists did so for preparing dispensed medications and checking their correctness.[75]

Of course, these efficiency gains need to be evaluated against the implementation costs. In Estonia, the direct implementation costs are estimated at €500,000, including one-off system implementation costs and annual maintenance costs, but excluding the large

Workflow: Protocol for a Time-And-Motion Study in English NHS hospitals," *BMJ Open*, Vol. 5, No. 10 (October 2015), e008785.

64 M. O. Roland, L. I. Zander, Mary Evans, Richard Morris, and R. A. Savage, "Evaluation of a Computer Assisted Repeat Prescribing Programme in a General Practice," *British Medical Journal (Clinical Research Edition)*, Vol. 291, No. 6493 (August 1985), pp. 456–458.

65 Åstrand et al., "Assessment of E-Prescription Quality: an Observational Study at Three Mail-Order Pharmacies."

66 Tim Dornan, Darren Ashcroft, Heather Heathfield, Penny Lewis, Jon Miles, David Taylor, Mary Tully, and Val Wass, *"An In-Depth Investigation into Causes of Prescribing Errors by Foundation Trainees in Relation to their Medical Education: EQUIP Study* (London: General Medical Council, December 2009); Hellström et al., "Physicians' Attitudes Towards E-Prescribing—Evaluation of a Swedish Full-scale Implementation."

67 Cornford et al., "The Evaluation of the Electronic Prescription Service in Primary Care."

68 Author interview.

69 Author interview.

70 EHIF, "Annual Report of the Estonian Health Insurance Fund," Yearbook, 2015.

71 Kierkegaard, "E-Prescription across Europe."

72 Center for Health Transformation, "Electronic Prescribing: Building, Deploying and Using E-Prescribing to Save Lives and Save Money," Report, December 2008.

73 Parv et al., "An Evaluation of E-Prescribing at a National Level."

74 Author interview.

75 Cornford et al., "The Evaluation of the Electronic Prescription Service in Primary Care."

cost of project management, system integration, and other operating expenditures.[76] The Swedish numbers confirm the need for viewing costs holistically: by 2008 (the eighth year of nationwide implementation), the cumulative investment costs including operating expenditure amounted to €155 million.[77] Then again, the sum of all of economic benefits was estimated at €97 millionin 2008, with cumulative benefits (since 2000, including investment and operating costs) of about €330 million.[78]

Health Benefits

A first cluster of health benefits of e-prescriptions is centred on **reduced error rates in medications**. Medical errors are a substantial problem in health care, with retrospective studies showing adverse effects for up to 17 percent of hospitalised patients, of which more than half were deemed preventable.[79] Common errors include drugs and dosages that are incorrect (or inappropriate for the specific patient), out-of-date drug information, missing checks for allergies and drug interactions, and a lack of identity control.[80] Consequently, error reduction at the stage of ordering, transcription, dispensing, and administration, as well as admission and discharge, may lead to improved patient safety, which in turn also has economic benefits.[81] These errors may be reduced, for example, through mandatory fields and sensible alerts from clinical decision support systems.

Indeed, various studies have found reduced errors due to e-prescriptions, although the magnitude of the impact differs widely. In Estonia, for example, the error rate was reportedly reduced to < 0.01 percent of all prescriptions,[82] with the EHIF estimating that 80,000 of patients (6 percent) will benefit from the avoidance of medication errors, according to Hoyer. In Sweden, prescription errors of delivered drugs and suggested dosages were reduced by 15 percent.[83] In a specific hospital in the UK, prescribing errors in a closed-loop system (without human intervention) were reduced from 3.8 percent to 2.0 percent; administration errors fell from 7 percent to 4.3 percent, while the frequency of patient identity checks increased from 19 percent to 83 percent before administering medicines.[84] This replicates findings about lower error rates with e-prescriptions in another UK hospital, where errors decreased from 6.7 percent to 4.8 percent by computerised physician order entry.[85]

Reduced error rates may also stem from enabling physicians to see patients' complete prescription histories. In a survey among Estonian doctors, 67 percent of primary care physicians said they made fewer mistakes due to seeing all the pharmaceuticals prescribed to a patient in their e-prescription system.[86] As Terje Peetso, policy officer in the European Commission's Unit Health and Wellbeing, Directorate-General for Communications Networks, Content and Technology, commented, "Thinking as a doctor, I can get the full overview of the medications, because it is in the same system, so I can avoid duplication or give a similar type of medication with another combination [of active ingredients]… that makes everybody's healthcare safer".[87] These benefits may be limited without appropriate decision support. Hoyer explained: "We hoped that the majority of doctors would evaluate medicines of every single patient, but many doctors, if not all, admitted that they don't have the actual time. Even if they have the data on their screens, they don't push the button to see previous medications."[88]

76 Kalvet et al., "E-Teenuste kasutamise tulemuslikkus ja mõju," as cited in Parv et al., "An Evaluation of E-Prescribing at a National Level."
77 European Commission, "E-Prescriptions: Apoteket and Stockholm County Council, Sweden—eRecept, an E-Prescribing Application," October 2008, http://www.ehealth-impact.org/case_studies/documents/ehealth-impact-7-2.pdf, accessed 23 March 2016.
78 Ibid.
79 Nicoletta C. Von Laue, David L. B. Schwappach, and Christian M. Koeck, "The Epidemiology of Medical Errors: a Review of the Literature," *Wiener Klinische Wochenschrift*, Vol. 115, No. 10 (May 2003), pp. 318–325; Åstrand et al., "Assessment of E-Prescription Quality: an Observational Study at Three Mail-Order Pharmacies."
80 Agrawal, "Medication Errors: Prevention Using Information Technology Systems"; Josip Car, Ashly Black, Chantelle Anandan, Kathrin Cresswell, Claudia Pagliari, Brian McKinstry, Rob Procter, Azeem Majeed, and Aziz Sheikh, "The Impact of E-Health on the Quality and Safety of Healthcare: a Systematic Overview and Synthesis of the Literature," Report for the NHS Connecting for Health Evaluation Programme (March 2008); Lisby et al., "Errors in the Medication Process: Frequency, Type, and Potential Clinical Consequences."
81 Car et al., "The Impact of E-Health on the Quality and Safety of Healthcare a Systematic Overview and Synthesis of the Literature"; Lisby et al., "Errors in the Medication Process: Frequency, Type, and Potential Clinical Consequences"; Dornan et al., "An In-Depth Investigation into Causes of Prescribing Errors by Foundation Trainees in Relation to their Medical Education: EQUIP Study."

82 Parv et al., "An Evaluation of E-Prescribing at a National Level."
83 European Commission, "E-Prescriptions: Apoteket and Stockholm County Council, Sweden—eRecept, an E-Prescribing Application."
84 Franklin et al., "The Impact of a Closed-Loop Electronic Prescribing and Administration System on Prescribing Errors, Administration Errors and Staff Time: a Before-And-After Study."
85 Rob Shulman, Mervyn Singer, John Goldstone, and Geoff Bellingan, "Medication Errors: a Prospective Cohort Study of Hand-Written and Computerised Physician Order Entry in the Intensive Care Unit," *Critical Care*, Vol. 9, No. 5 (August 2005), R516.
86 Kalvet et al., "E-Teenuste kasutamise tulemuslikkus ja mõju," as cited in Parv et al., "An Evaluation of E-Prescribing at a National Level."
87 Author interview.
88 Author interview.

Other research, however, concluded that error rates between paper-based and electronic systems did not greatly differ for either hospitals or pharmacies.[89] While there were fewer omissions in e-prescriptions, prescribing errors remained stable, or sometimes even increased, particularly during the initial phase of system use.[90] E-prescribing systems may also create new errors,[91] with "alert fatigue" further contributing to the problem: doctors clicking alerts away when they appear.[92] In a UK-based study, out of 117 alerts, only 3 actually prompted the GP to check, but not to alter the prescription—which the authors attributed to clinical decision support not being aligned with the prescribing workflow, because decisions were already taken when the alert came up.[93] In that sense, there are limitations to clinical decision support in e-prescribing.

A final question in the context of error reduction is whether e-prescriptions address the important errors—and thereby contribute to avoiding harm. Some avoided errors may reduce harm, although both actual and potentially harmful prescriptions could not be eliminated through e-prescribing.[94] The evidence is unclear, partially because harm is relatively infrequent; there are only a few studies powered with the required amount of patient years to detect effects on harm reduction, and harm may be defined differently in each study.[95] As Aziz Sheikh from the Usher Institute of Population Health Sciences and Informatics at the University of Edinburgh summarised: "Are some errors being prevented? Yes. Are these the ones that matter? Yes, potentially. And does it translate into actual reduction in harm? Difficult to say, but it probably will be reducing some harm."[96]

Second, there may also be health benefits due to the potentially **better accessibility of medicines,** enabled by the ease associated with e-prescriptions. This may particularly relate to time-critical medications, and those linked to stigmatised or embarrassing conditions. As Aaviksoo reported, the Estonian data suggests that easier availability of emergency contraceptives through the use of e-prescriptions may have resulted in a reduction of unwanted pregnancies and, as a result, abortions: "There is some statistical correlation […]hard science has not proven it, there could be many reasons, but there definitely is some correlation."[97] Further research into these wider social benefits would be worthwhile to create reliable scientific evidence.

A third cluster of health benefits may also occur around **monitoring adherence to physician recommendations.** In the case of repeat prescriptions, automated reminders generated through e-prescription systems may help to remind patients to pick up refills of their medication. At the same time, e-prescriptions also allow for tracking who actually fills their prescriptions. For example, a U.S.-based study concluded that among patients with prescriptions for diabetes, blood pressure, or cholesterol medications, nonadherence was reduced from around 22 percent to only 7–13 percent (for all three kinds of drugs) when e-prescriptions were used, as measured by the rate of patients who picked up their prescriptions.[98]

Similar challenges exist in Estonia, as Aaviksoo reported: "We know that 20 percent of the patients […] did not buy the drug that was prescribed to them. […] So [e-prescription information] can be used at the policymaking level to design better and more effective policy measures, and also by family doctors: then the

89 Ahmed et al., "Impact of Electronic Prescribing on Patient Safety in Hospitals—a Review of Reviews with a Focus on the UK Implications"; and Cornford, et al., "The Evaluation of the Electronic Prescription Service in Primary Care."

90 Evans et al., "A Comparison of Handwritten and Computer-Assisted Prescriptions in an Intensive Care Unit;" D. Mitchell, J. Usher, S. Gray, E. Gildersleve, A. Robinson, A. Madden, J. Smith, and D. Sanderson, "Evaluation and Audit of a Pilot of Electronic Prescribing and Drug Administration," *Journal on Information Technology in Healthcare*, Vol. 2, No. 1 (January 2004), pp. 19–29, as cited in Ahmed et al., "Impact of Electronic Prescribing on Patient Safety in Hospitals—a Review of Reviews with a Focus on the UK Implications."

91 Barber et al., "Safer, Faster, Better? Evaluating Electronic Prescribing"; Johanna I. Westbrook, Margaret Reckmann, Ling Li, William B. Runciman, Rosemary Burke, Connie Lo, Melissa T. Baysari, Jeffrey Braithwaite, and Richard O. Day, "Effects of Two Commercial Electronic Prescribing Systems on Prescribing Error Rates in Hospital In-Patients: A Before and After Study," *PLoS Med*, Vol. 9, No. 1 (January 2012), e1001164; Lapane, Kate L., Molly E. Waring, Catherine Dubé, and Karen L. Schneider, "E-Prescribing and Patient Safety: Results from a Mixed Method Study," *American Journal of Pharmacy Benefits*, Vol. 3, No. 2 (October 2011), pp. e24–e34.

92 Heleen Van Der Sijs, Jos Aarts, Arnold Vulto, and Marc Berg, "Overriding of Drug Safety Alerts in Computerized Physician Order Entry," *Journal of the American Medical Informatics Association*, Vol. 13, No. 2 (March 2006), pp. 138–147; Schade et al., "E-Prescribing, Efficiency, Quality: Lessons from the Computerization of UK Family Practice."

93 James Hayward, Fionagh Thomson, Heather Milne, Susan Buckingham, Aziz Sheikh, Bernard Fernando, Kathrin Cresswell, Robin Williams, and Hilary Pinnock, "'Too Much, Too Late': Mixed Methods Multi-Channel Video Recording Study of Computerized Decision Support Systems and GP Prescribing," *Journal of the American Medical Informatics Association*, Vol. 20, No. e1 (June 2013), pp. e76–e84.

94 Shulman et al., "Medication Errors: a Prospective Cohort Study of Hand-Written and Computerised Physician Order Entry in the Intensive Care Unit."

95 Barber et al., "Safer, Faster, Better? Evaluating Electronic Prescribing."

96 Author interview.

97 Author interview.

98 Marsha A. Raebel, Jennifer L. Ellis, Nikki M. Carroll, Elizabeth A. Bayliss, Brandy McGinnis, Emily B. Schroeder, Susan Shetterly, Stan Xu, and John F. Steiner, "Characteristics of Patients with Primary Non-Adherence to Medications for Hypertension, Diabetes, and Lipid Disorders," *Journal of General Internal Medicine*, Vol. 27, No. 1 (January 2012), pp. 57–64.

discussion is not about whether this drug was effective or not, but rather why [people] didn't pick it up."[99] As the quote reflects, however, e-prescriptions may enable further action rather than solving the problem itself. An analysis of Estonian patients who were prescribed beta-blockers, statins, and ACE inhibitors for unstable angina, acute myocardial infarction, and heart failure shows that the percentage of patients who picked up all of their medications remains relatively low, and did not greatly change between the period before e-prescriptions in 2008 and afterward in 2013.[100]

A final health benefit relates to the possibility for **aggregate analysis in the health system**. As Lisa Hagberg, international coordinator from the Swedish eHealth agency explained: "We also have the benefit on the aggregate level to follow up statistically on a national level, which a lot of actors in the healthcare field use: to understand the appropriateness of medication for different population groups, research prescriptions of antibiotics so that drug resistance is reduced, and evaluate new costly medications."[101] This benefit of e-prescriptions offers new opportunities for clinical research and emergent learning health systems, both in the sense of comparative effectiveness research, and potentially also for clinical trial recruitment.[102]

In addition, aggregate analyses in the health system enable pharma companies to prove the effectiveness of their drugs. Obtaining this proof of efficiency is relevant for regulators in particular, as they continuously make decisions about which pharmaceutical products should be reimbursed in the country. Aaviksoo also highlighted the potential benefits for regulatory approval of drugs beyond country borders: "It's difficult to gather information on the side effects of drugs, and that prevents regulators from allowing drugs on the European market earlier. If we could allow drugs on the European market earlier, but with very strong pharmacovigilance afterwards in the post-market period, and then use the information to understand benefits and side effects, that would benefit patients, the health system, and drive some economic benefits for the pharmaceutical industry."[103]

Social Benefits

In the context of social benefits, e-prescriptions may contribute to overall **patient satisfaction with the health system**. In Estonia, about 92 percent of individuals that had used e-prescriptions were either very satisfied or satisfied with the service about one year after their launch, while in a 2015 survey, e-prescriptions were among the most popular e-services in Estonia.[104] This may relate to the convenience associated with repeat prescriptions, but also to picking up prescriptions while travelling. Similar satisfaction rates were reported in the interviews and in the existing literature for the Nordic countries, such as Sweden, where 85 percent showed very positive attitudes toward e-prescribing.[105]

Of course, both patient satisfaction and uptake of the system also depend on the service levels provided previously. In the UK, many pharmacies were already offering services for repeat prescriptions before the introduction of the new system,[106] so that little changed for patients. As Emeritus Nick Barber from University College London (UCL) School of Pharmacy argued: "Pharmacists had already set up processes by which they go and collect the prescription for you from the GP. So there's no difference for the patient, most pharmacists have done this for free to get the trade, so the competition—as we have a competitive market for community pharmacies—the competition has driven them to deliver the service in effect without the technology."[107]

In addition, patient satisfaction may again depend on the specific implementation. A consequence of the system architecture in the UK based on the Spine is that sometimes patients may arrive at the community pharmacy more quickly than their e-prescription.[108] The need to nominate a specific community pharmacy in the UK may also reduce flexibility for the patient, as Bryony Dean Franklin from the Centre for Medication Safety and Service Quality at Imperial College Healthcare NHS Trust, London and UCL School of Pharmacy explained: "Patients sometimes feel that they can't just drop in to a different pharmacy on their way home from work, because it's already been sent to their nominated pharmacy."[109]

Moreover, recent research has suggested that in both hospital inpatient settings and community settings,

99 Author interview.
100 World Bank Group, "The State of Health Care Integration in Estonia."
101 Author interview.
102 Tom Foley and Fergus Fairmichael, "The Potential of Learning Healthcare Systems," Report, The Learning Healthcare Project, November 2015.
103 Author interview.

104 EHIF, "Digital Prescription"; E-Estonia.com, "e-Prescription."
105 Hammar et al., "Patients Satisfied with E-Prescribing in Sweden: a Survey of a Nationwide Implementation."
106 Cornford et al., "The Evaluation of the Electronic Prescription Service in Primary Care."
107 Author interview.
108 Ibid.
109 Author interview.

e-prescriptions may not support the model of patient-centred care, but rather act as an additional barrier for patient involvement as a critical factor in the transition of responsibility from the state and health professionals to the individual.[110] Franklin voiced concerns about e-prescriptions, because "[patients] now need a healthcare professional to tell them what's on the prescription, which usually means going to the doctor's office, logging in, there might be no way the patient can actually see the screen […] the disadvantage is that patients don't get to see what they've been prescribed before they take it to the pharmacy."[111]

Another social benefit may also be a **financial relief for society**. In countries such as Estonia and Denmark, the government covers large parts of the medication costs, with individual co-payments depending on the circumstances and the amount of medication already received in a given year. In both countries, the shift toward prescribing active ingredients or the cheapest generic available reduced patient co-payments. Particularly for those living on small budgets with high medication costs—such as retired people, as Hoyer remarked—this makes a substantial difference. In addition, e-prescriptions also increased transparency about these costs for individuals, as Ib Johansen from the Danish eHealth agency Medcom described, "The government would use the expenses from all pharmacies for refunding, and because they have the IT systems in the pharmacies, you could go to whatever pharmacy and see how much you have spent."[112]

Finally, e-prescriptions can improve **social care for the elderly**. As Peetso from the perspective of an Estonian user commented, "[I very much value] the possibility that if I have forgotten to take [my father's] papers with me, but I happen to be in the pharmacy, I can just check [...] whether he has any pending prescriptions".[113] Similar statements were made by interviewees from other countries. This shows how also the burden of care—as one of the major challenges of an aging society going forward—may be partially relieved through e-prescription systems.

* * *

Linking these economic, health, and social benefits to specific stages of policy implementation is difficult because stages of policy implementation are not always separable. In general, however, benefits tend to be realised toward the final stages of implementation, as Sheikh summarised: "Benefits tend to come pretty late, although policymakers want them to come incredibly early—unrealistically early—and that is what in part causes the problems that we have."[114]

The existing literature and the interviews evidenced various drivers for benefit realisation: the first is the uptake of the service because benefits often only come with a critical mass.[115] In Estonia, uptake was very rapid, so according to Aaviksoo, many of the financial benefits could already be observed after the first year of service introduction.[116] In Sweden, with a flatter curve of uptake, the first year of annual net benefit was in 2005, the fifth year of the program, when approximately 50 percent of prescriptions were sent electronically. Benefits grew with further dissemination: the first year of cumulative net benefit in Sweden was reached in the sixth year.[117]

Second, it is possible to separate benefits by the use of computerised physician order entry and bar-coding systems on the one hand, and electronic transmission on the other hand. As the UK experience showed, a substantial share of the value was already generated through legible and complete medication orders.[118] The health benefits, in particular, were already realised by electronic data capture and bar-coded administration systems,[119] while the lack of suitable user interfaces was also identified as a common source of failure to derive benefits.[120] In addition, many benefits just "come as a result of having your data digitised, as that enables all sorts of potential additional analyses around issues to do with the appropriateness of prescribing—the kinds of analyses that would not be possible with paper-based systems," as Sheikh explained.[121]

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110 Sara Garfield, Seetal Jheeta, Fran Husson, Jill Lloyd, Alex Taylor, Charles Boucher, Ann Jacklin, Anna Bischler, Christine Norton, Rob Hayles, and Bryony Dean Franklin, "The Role of Hospital Inpatients in Supporting Medication Safety: A Qualitative Study," *PloS one*, Vol. 11, No. 4 (April 2016), e0153721; Lisa Lee, Robin Williams, and Aziz Sheikh, "What Does E-Prescribing Mean for Patients? A Case Study of the Perspectives of Hospital Renal Patients," *Journal of Innovation in Health Informatics*, Vol. 22, No. 4 (November 2015), pp. 391–398.

111 Author interview.

112 Author interview.

113 Author interview.

114 Author interview.

115 Cornford et al., "The Evaluation of the Electronic Prescription Service in Primary Care."

116 Author interview.

117 European Commission, "E-Prescriptions: Apoteket and Stockholm County Council, Sweden—eReceipt, an E-Prescribing Application."

118 Cornford et al., "Electronic Prescribing in Hospitals—Challenges and Lessons Learned."

119 Agrawal, "Medication Errors: Prevention Using Information Technology Systems."

120 Hagstedt, Lovisa, Carl Rudebeck, and Göran Petersson, "Usability of Computerised Physician Order Entry in Primary Care: Assessing E-Prescribing with a New Evaluation Model," *Journal of Innovation in Health Informatics*, Vol. 19, No. 3 (July 2011), pp. 161–168.

121 Author interview.

Finally, as argued in the introduction to this section, benefit realisation depends to a large extent on how well the system is integrated in existing workflows and with other services, which depends both on the country and the implementation in the care setting. To a certain extent, e-prescribing may just be an infrastructure, which offers the *potential* for savings and better information management.[122] In that sense, it cannot be claimed that e-prescriptions will generally have positive effects, particularly in the early stages of implementation. The underlying success factors for introducing e-prescriptions and deriving benefits will be explored in the following section.

SUCCESS FACTORS FOR ADOPTING E-PRESCRIPTIONS

To introduce e-prescriptions and realise their benefits, some central success factors will be necessary. These are closely interlinked and presented here by moving from the more technical aspects to those related to the design and execution of e-prescribing initiatives. Technical aspects are often at the centre of attention, but equally important are a holistic view of organisational processes, structures, legislation, and investment in the human resources setting up, maintaining, and working with the system, any of which may derail the project if neglected.[123] As Åstrand put it, one must "have the right people in the right places, have a common goal and work towards it."[124]

Digital Maturity in the Health System and the Country

First, many interviewees highlighted that e-prescriptions depended on other digital infrastructures in the health system. While computerisation in the health system is now high across EU nations,[125] reception of wireless connections remains challenging in some care settings,[126] even today, as interviewees reported. In addition, the availability of EMRs and general health information exchange in the country is important. Peetso stressed: "Everything belongs to the same family. I don't think there is a specific e-prescription strategy [...] it is part of an overall e-health strategy. [...] You cannot have one without the other. If health records are kept on paper, there is no link [to e-prescriptions] [...] so that means double work."[127]

In all four case studies, the countries in principle introduced EMRs alongside e-prescriptions—although it is worth highlighting that Denmark primarily scaled both with increasing computerisation in the health system in the 1990s. Johansen explained that this also went hand in hand with further services that encouraged practitioners and pharmacies to invest in information technology: "[Doctors] were receiving all the lab test results and discharge summaries from hospitals electronically, so they had more benefits of investing in computers. So it's not only prescriptions. [...] And today, it is mandatory to do these electronically, they cannot [do this] on paper anymore."[128]

It is also important for these services to be interoperable, both for user acceptance and benefit realisation.[129] Franklin argued that in the hospital inpatient setting "[benefits] depend on whether a system is integrated [...]: is it the same system that can also be used for discharge, across different clinical areas, and that also contains the other EMR information? Because if these systems are all very piecemeal, you don't get many of the benefits."[130] While there may be different approaches on the continuum between best-of-breed strategies and enterprise systems, integration often remains a challenge. At the same time, Åstrand pointed to the need for a sensible balance: "It's important that it's linked to the extent that is needed, but not to everything in an eHealth strategy, because then it can take decades before you will have e-prescriptions."[131]

In addition, wider digital maturity is crucial due to the opportunity for reusing existing infrastructure for data exchange, as Hoyer argued: "The key factor was that there was a political decision in terms of our IT development in Estonia. [...] Our national infrastructure enabled us as service designers and providers to focus on

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122   Cornford et al., "The Evaluation of the Electronic Prescription Service in Primary Care."

123   WHO, "From Innovation to Implementation: E-Health in the WHO European Region."

124   Author interview.

125   Sabina De Rosis and Chiara Seghieri, "Basic ICT Adoption and Use by General Practitioners: an Analysis of Primary Care Systems in 31 European Countries," *BMC Medical Informatics and Decision Making*, Vol. 15, No. 1 (August 2015), pp. 70–86.

126   Cornford et al., "Electronic Prescribing in Hospitals—Challenges and Lessons Learned."

127   Author interview.

128   Author interview.

129   Kathrin M. Cresswell, Hajar Mozaffar, Lisa Lee, Robin Williams, and Aziz Sheikh, "Safety Risks Associated with the Lack of Integration and Interfacing of Hospital Health Information Technologies: a Qualitative Study of Hospital Electronic Prescribing Systems in England," *BMJ Quality & Safety* (March 2016), bmjqs-2015; Cornford et al., "The Evaluation of the Electronic Prescription Service in Primary Care."

130   Author interview.

131   Author interview.

service design and functionalities. […] And by having no area-specific infrastructure for e-solutions, we didn't have to reinvent the wheel again." Furthermore, based on the existence of the X-road as a central backbone of all services, "we didn't have issues in terms of the security, or authentication of users—these huge issues were already solved."[132]

Thoughtful Process and System Design

For e-prescriptions to be implemented successfully, processes need to be well designed in the context of the overall health system and other adjacent services. E-prescriptions must be approached as a sociotechnical innovation,[133] and workflow problems were identified as a challenge in several evaluations,[134] either because they were not given enough consideration, or because they omitted input from key stakeholders.[135] This was also a key lesson in Estonia, as Aaviksoo explained: "[It is crucial to] have strong commitment at the design phase, so that the process that is technologically implemented is really logical and accepted by the stakeholders. Our experience from other services is that if this agreement around business process is not solved initially, it has a large risk of stalling the whole service up to the very end."[136]

This relates both to system acceptance and subsequent benefit realisation, which are closely related. A success factor for adoption in Denmark was doctors' desire to use e-prescriptions, as Johansen argued: "It was much easier for the prescriber to make an electronic prescription instead of a paper prescription, and then document it manually in the [EMR]. And […] in the EMR system, they had a complete medication list with indications, with the updated prices, so it was much easier for them to prescribe the correct medication. The GPs were eager to use it!"[137] Similarly, many UK interviewees related process inefficiencies to a lack of benefit realisation, highlighting that, particularly in hospitals, more can be done to involve patients, improve waiting times, and smooth workflows. Sheikh stated: "On so many fronts, it is still a bit of a frustrating experience for professionals and patients, and we're not anywhere near realising the benefits of these systems."[138]

Closely related is the translation of the designed process to the IT systems.[139] Barber said: "People really need to extract the stories of problems, because there is a big language gap between the computer system suppliers who are often paid by meeting milestones, so it's in their interest to push something through rapidly rather than get it right, and the users are not savvy and believe that these people are the experts."[140] User-friendliness was particularly perceived as a problem by the UK interviewees, as summarised by Sheikh: "None of these systems appear to be particularly intuitive or well-designed at the moment. […] There needs to be a genuine commitment to user-centred design, rather than lip service to it. I don't think we really understand the sociotechnical dimensions, people are struggling with the number of alerts they are getting, and we probably just need to think about next generation alert mechanisms."[141] For example, alerts may become more intelligent by moving from rule-based systems to pattern recognition, and need to be more closely aligned with well-designed clinical workflows.

Several UK interviewees supported the view that e-prescription software needed to be further optimised. For this, it is also important to develop a good relationship with the software suppliers,[142] and rethink current market structures with oligopolies of software vendors.[143] Sheikh explained: "The vendors [of health information systems] are an important part of the mix, but we're not getting any traction with [them]. It's quite difficult because there are so few of them, and they are kind of in a monopoly position. […] There is a lack of competition for these established vendors."[144] Consequently, existing legacy systems create challenges to innovation, with little incentives for vendors to actively support interoperability. However, facilitation of standards, as will be discussed in the next subsection,

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132   Author interview.
133   Barber et al., "Safer, Faster, Better? Evaluating Electronic Prescribing."
134   Villalba van Dijk et al., "Electronic Prescribing in the United Kingdom and in the Netherlands"; Agrawal, "Medication Errors: Prevention Using Information Technology Systems"; Cornford et al., "The Evaluation of the Electronic Prescription Service in Primary Care."
135   Cornford et al., "Electronic Prescribing in Hospitals—Challenges and Lessons Learned."
136   Author interview.
137   Author interview.
138   Author interview.
139   Sean W. Smith and Ross Koppel, "Healthcare Information Technology's Relativity Problems: a Typology of How Patients' Physical Reality, Clinicians' Mental Models, and Healthcare Information Technology Differ," *Journal of the American Medical Informatics Association*, Vol. 21, No. 1 (January 2014), pp. 117–131.
140   Author interview.
141   Author interview.
142   Cornford et al., "Electronic Prescribing in Hospitals—Challenges and Lessons Learned."
143   Ross Koppel and Christoph U. Lehmann, "Implications of an Emerging EHR Monoculture for Hospitals and Healthcare Systems," *Journal of the American Medical Informatics Association*, Vol. 22, No. 2 (October 2014), pp. 465–471.
144   Author interview.

may be one way to allow for open innovation in that space.

Facilitation of Standards

In principle, standards for data exchange are necessary for nationwide e-prescription solutions, as highlighted by the interviewees and publications from all four case studies. This includes both an interoperability framework for secure information exchange between prescribers and dispensers, and a data model and minimum dataset including reference catalogues.[145]

For example, a key success factor in Denmark was the existence of the eHealth agency Medcom. As Johansen recounted: "[Medcom] defined the standards, tested and approved the system, and put a stamp on it to say 'okay, this is not a bad system—and don't buy a system which is not approved, because then there will be some functionalities missing' […] All IT vendors had to use the same standards. You should not build islands that can only communicate with the local partners. So from the very beginning, you could send a prescription to whatever pharmacy in the country."[146] In addition, Denmark has a central medicines agency producing a file of drugs with their name, content, substitute products, prices, and dosage codes, which was also implemented in EMR systems used by GPs.

Common standards also allow for a certain degree of innovation in e-prescribing, as discussed in the previous section, and customisation to local needs.[147] As Sheikh explained in the context of UK hospitals, "most are probably going to end up with enterprise systems, and then the innovation and local customisation probably will need to come through a layer of apps. But that needs APIs [application programme interfaces] of these systems to be made open. […] The NHS could centrally catalyse innovation, it could help by specifying some minimum standards, it could undertake the assessments of the usability of systems and make recommendations […], [thereby] encouraging new entrants [and] facilitating the whole contraction process […] but it does need the NHS' leadership to understand these issues."[148]

Facilitation of standards also includes a common patient identifier across care settings. Johansen said that "it is

the key for all systems to access the patient data that we have a unique identifier for each citizen," while Nikolaj Kolte, deputy IT director for the Central Jutland Region in Denmark, added: "You simply cannot live a day in Denmark without that number,"[149] showing its widespread use in everyday life. Another example is the Estonian eID. In the words of Peetso: "One precondition for effectively using e-prescriptions […] was our eID. It helps identification procedure in the pharmacy and accessing your prescriptions from home."[150]

A final aspect related to common standards is a suitable legal framework, with many countries having passed some form of legislation to enable eHealth innovation. This is important both for the enablement of these services, but also for the protection of citizens against misuse and data leakage beyond technical measures.[151] Regulation usually tends to lag behind, however, so that to a certain extent, as Åstrand argued, "You have to work with the available regulations that you have on a national level […] for hundreds of years, there have been regulations about prescriptions, and you cannot really hope that all of those regulations are changed to a new eHealth world."[152]

Leadership and Stakeholder Alignment

A common denominator among the interviewees was the importance of central leadership to align stakeholder interests, coupled with strong local involvement in the rollout. This is necessary to combine the benefits of a top-down vision and bottom-up user acceptance.[153] Peetso summarised the point: "The bottom-up approach is the preferred way of what we do nowadays—but sometimes it is good if this bottom-up approach is combined with top-down […] [to] have one nation-wide system, which has taken into account the interest and wishes from the end-users, and is really user-friendly."[154] To a certain extent, Denmark struck this balance by first convincing users of the benefits of e-prescriptions and then mandating its use later. Johansen stated: "Other European countries […] decided that they could not have anything refunded if the prescription was not electronic, so in one year all prescriptions were electronic. But is not the Danish culture to do it like that. We prefer to have it voluntarily

145 HIQA, "E-Prescribing and Electronic Transfer of Prescriptions: An International Review."
146 Author interview.
147 Barber et al., "Safer, Faster, Better? Evaluating Electronic Prescribing."
148 Author interview.

149 Author interview.
150 Author interview.
151 Kierkegaard, "E-Prescription across Europe."
152 Author interview.
153 Villalba van Dijk et al., "Electronic Prescribing in the United Kingdom and in the Netherlands."
154 Author interview.

and say 'okay, you can see the benefits'—and then after that, then we decide that it should be mandatory."[155]

There are various possibilities for who can fulfil this leadership role. In Estonia, the implementation was initially led by the Estonian e-health foundation (a private entity established by the state, the EHIF, the largest hospitals, and associations of family physicians) and then transitioned to the EHIF altogether. In Sweden, the government-owned pharmacy first took the lead, then handed it over to the Swedish eHealth agency after the deregulation of the pharmacy market. In Denmark, leadership stayed with the eHealth agency Medcom throughout the whole process. In the UK, the NHS coordinates e-prescriptions for primary care, with largely decentral responsibility in secondary care after the demise of the NPfIT. Who takes the lead also depends on country-specific structures, according to Åstrand, formerly the head of e-health services at the Swedish national pharmacy Apoteket AB, which is responsible for e-prescribing services: "People often say 'but you were special in Sweden, you had only one national pharmacy chain run by the government'. And I'd say […] 'Denmark, they were as good as Sweden, they had private pharmacies—but there was another body who took that role and was the forerunner.' The most important thing is to find out who can take the lead in a country: it must have financial resources, but also the respect and reputation from the other parties involved, […] and needs to have a national perspective."[156]

Leadership also means that all stakeholders should be integrated into this effort from the beginning. As Annika Ohlson from the Swedish eHealth agency explained, a key success factor in Sweden was "the cooperation between all involved stakeholders. You have to be a team on this, and very firm on what you want to achieve […] and to do this together with the regions."[157] Similarly, as Sheikh summed up, "What it needs is a combination of a centralised government function and local providers having ownership. In the UK, with the NPfIT, we had too much centralisation, and then after the demise of the Programme, we had too much local ownership—so the pendulum swung from one extreme to the other. What needs to be done is finding a middle course through this."[158] For example, while the national leader should set the vision, identify clinical priorities for benefit realisation, think about incentives aligned around these, and provide standards, there may be some customisation, choice, and

possibilities for innovation at the local level in order to create buy-in and ownership.

Incentives and Change Management

Stakeholder alignment also means that the benefits of the new system must be visible to all stakeholders in order to achieve widespread acceptance, particularly when linked to financial incentives. Aaviksoo explained: "By Estonian law, doctors are responsible for marking the correct reimbursement rate on the prescription […] if they mark that [reimbursement] incorrectly, they will be liable later on: the difference between the excess money paid by the health insurance fund will be deducted from their payment. So information technology helped them to crunch through that algorithm […] and they had a financial interest in doing that."[159] Similarly, in the UK, pay-for-performance reimbursement mechanisms may incentivise adoption.[160] It may be debated whether these incentives are offset by the time-consuming activities linked to e-prescription adoption.[161] In any case, there must not be any conflicting incentives: as discussed before, e-prescriptions reducing office visits only helps if GPs are not paid in fee-for-service systems.[162]

On the pharmacy side, competitive forces may be seen as the main driver for achieving the high level of pharmacy adoption in Denmark, Estonia, and the UK.[163] Johansen explained that "the pharmacies, they all invested in computers with their own money because if they couldn't receive electronic prescriptions, they would have missed some patients... and so they would have less revenue. That was a normal market condition."[164] As discussed above, in Sweden the situation was different because the pharmacies were already in charge of introducing e-prescriptions, but Sweden used an element of competition for driving adoption in the regions by making adoption rates transparent: "People don't want to be number one, but people don't want to be the last one," as Åstrand stated regarding the success of this cost-effective method.

Finally, incentives are just part of a wider need for change management within every organisation adopting

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155 Author interview.
156 Author interview.
157 Author interview.
158 Author interview.

159 Author interview.
160 Villalba van Dijk et al., "Electronic Prescribing in the United Kingdom and in the Netherlands."
161 Cornford et al., "The Evaluation of the Electronic Prescription Service in Primary Care."
162 Villalba van Dijk et al., "Electronic Prescribing in the United Kingdom and in the Netherlands."
163 HSCIC, "Statistics and progress"; Cornford et al., "The Evaluation of the Electronic Prescription Service in Primary Care."
164 Author interview.

a new system. In addition to incentives, people need to understand the benefits of the new system, and develop their own motivations for using it. Ohlson explained: "Users really had to experience the benefits in order to change. I think it's the same for almost every IT system. […] First you have to realise it by the facts, but then you need the motivation to change your behaviour, to get really into this. In some ways you have to be forced to use it and dig into it."[165] In Denmark, this process was further supported by Medcom informing future users about the benefits and drawbacks based on experiences of previous implementers, and by training users as an important factor not only for adoption, but also benefit realisation.

Trust and Digital Readiness of the Population and Workforce

Other success factors mentioned in several interviews were trust and people's digital readiness. As discussed briefly in the second section of this paper, e-prescriptions may raise privacy concerns, and trust is an important prerequisite, as Peetso highlighted: "You can't sell trust, or [ask people to] sign for trust […] it has to be somehow incorporated—so that the [overall] system creates the trust."[166]

On the one hand, trust is shaped by how data is handled. Aaviksoo ascribed the high level of trust in Estonia to the absence of any major technology-driven data breaches, with only 0.6 percent of the population opting out of sharing medical documents, including e-prescriptions. He saw the primary reason for this in "the gradual introduction of value-adding services, and not failing in any of them," in addition to suitable laws and consequential prosecution of smaller data breaches.[167] He also acknowledged that governments need to continue facing future legal and technological challenges, and proactively addressing them to stay ahead of potential concerns of their populations. In the United Kingdom, NHS data breaches are more commonly reported, citizens do not have ID cards partially due to privacy-related reasons, and willingness to disclose personal information for electronic services is lower than in other EU countries.[168]

On the other hand, interviewees from Estonia, Sweden, and Denmark highlighted that citizens are accustomed to and even expect to have various e-services such as tax filing, voting, and digital signatures.[169] According to Kolte, "In Denmark we trust that the government handles our data correctly. We actually expect that the government takes care of that kind of information for us. So we would say: why doesn't the government handle my e-prescription? Why do I need to be involved? That would be a Danish argument."[170] Acceptance of Danish and Swedish physicians is also shaped by the long history of e-prescriptions, as Åstrand brought up: "I don't think you can go from 0 to 100 or 90 percent over night. You have to adapt to the idea and then see if this is not dangerous – if the patients like it, the physicians like it, and the pharmacists like it. They needed confirmation that this was a technology that everyone liked – that was maybe the most important thing during the 80s and 90s."[171]

In addition, the population may also act as an active driver for change.[172] Hoyer reported that in Estonia, pharmacies did not fully support the implementation of e-prescriptions and demanded financial support for their implementation from the government. In the end, however, they had to adopt the service based on competitive pressure from the population, "as patients wanted to use the service, they chose the pharmacies which had implemented the solution, and therefore [these pharmacies] had to implement the service. Of course, the requirement was in the legislation as well, but this was not enough."[173] This again depends on the service level at the outset, with UK pharmacies already offering similar services before the introduction of e-prescriptions, although competitive forces still drove the high level of pharmacy adoption (99 percent) today.[174]

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165 Author interview.
166 Author interview.
167 Author interview.
168 Wainer Lusoli, Margherita Bacigalupo, Francisco Lupiáñez-Villanueva, Norberto Andrade, Shara Monteleone, and Ioannis Maghiros, "Pan-European Survey of Practices, Attitudes and Policy Preferences as Regards Personal Identity Data Management," Scientific and Policy Reports EUR 25295, European Commission, Joint Research Centre, Institute for Prospective Technological Studies, Luxembourg, June 2012.

169 Mary-Louise Jung and Karla Loria, "Acceptance of Swedish E-Health Services," Journal of Multidisciplinary Healthcare, Vol. 3 (November 2010), pp. 55–63; Patrick Kierkegaard , "E-Health in Denmark: a Case Study," Journal of Medical Systems, Vol. 37, No. 6 (December 2013), pp. 1–10.
170 Author interview.
171 Author interview.
172 Pēteris Zilgalvis and Sven Jungmann, "From Spectators to Change Agents. Empowering European Citizens as Drivers of E-Health Innovation," Cyber Studies Working Paper Series, No. 2, University of Oxford (June 2015).
173 Author interview.
174 HSCIC, "Statistics and Progress"; and Cornford et al., "The Evaluation of the Electronic Prescription Service in Primary Care."

A Suitable Implementation Plan

Finally, a plan for a coordinated rollout was a central success factor. On one end of the spectrum, Estonia introduced e-prescriptions in a big bang approach. While successful in the end, the system initially faced capacity constraints despite the relatively small country size. As Aaviksoo explained, these problems mainly resulted from the unexpectedly quick uptake and the limitations of testing the system with all stakeholders before it went live. According to him, "Managing expectations is extremely important: not to overpromise what will be the benefits of the system, but also managing expectations in the sense that with digital services, initially there will be some issues."[175] An implementation strategy should therefore be conscious about the overall burden put on the organisation and the number of IT systems changed at once. As Barber reported, "[A specific hospital in the UK] tried to […] roll out e-prescriptions and also interact with the Spine. And the Spine team was very small, and there was hardly anybody there who understood the complications […] so things weren't piloted and often pushed through very rapidly." Consequently, expectation management is important in the UK context as well, as Sheikh explained: "I think we get our timelines wrong, we overestimate the benefits. We promise too much, and deliver too little, which leaves people frustrated."[176]

In contrast, Sweden opted for a decentralised rollout, following the Stockholm-based pilot. For each locality, introduction was planned locally, including training and operational start-up, followed by evaluation meetings three to six months after beginning operations.[177] The structured implementation strategy with a central pilot program and competition-driven rollout was seen as a central success factor in Sweden by several interviewees. In Denmark, the rollout had a different flavour because there was a natural rollout of e-prescriptions alongside the computerisation of the health system, showing how implementation strategies also depend on the period in which they take place.

On the other end of the spectrum, the constituent countries of the UK even defined separate stages, with paper systems in primary care either being included in the solution, or paper systems being supported in parallel for a certain timeframe.[178] This phased approach was necessary due to the country's size and the resulting complexity, with the need for parallel operations to avoid patients being issued electronic prescriptions that pharmacies in their local area could not yet dispense. Particularly for larger countries, it is important to ensure some early successes to build momentum and avoid an extensively long journey with parallel systems for an extended period of time, which may result in additional administrative effort and lower safety.[179]

A final success factor regarding implementation that experts from several countries mentioned was to identify change champions. In the words of Ohlson: "You have to have a structure for the implementation, and some sort of gradual development—first you win some, and then you win the rest."[180] Similarly, Åstrand said: "First you have the wild and crazy ones, but then […] you must somehow get the influential people to like the technology and spread the word about it before you get it to take off."[181] More generally, identifying those who enthusiastically embrace change, but also some strong dissenters, may be a good strategy for building up a critical mass and driving implementation.[182]

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To summarise, success factors around the introduction of e-prescriptions and realisation of their benefits depended on the interplay of technical and organisational features. Finally, nearly all interviewees brought up smaller size as an advantage—for example, in terms of the lower number of stakeholders, shorter communication links, and higher degrees of innovation power, which have contributed to making nations such as Sweden, Denmark, and Estonia leaders in digitisation.[183] Then again, size is not everything. Smaller countries often have disproportionally lower budgets and, as Åstrand argued, although "it's easier to make it for 9 million people than for 90 million people, it's more of a question of how healthcare and pharmacies, government, are organised," as well as mindset shifts around abolishing legacy thinking, investment priorities in human capital and development, and a focus on the success factors presented in this section.[184]

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175   Author interview.
176   Author interview.
177   Vardgivarguiden, "E-Prescriptions in Sweden."
178   HIQA, "E-Prescribing and Electronic Transfer of Prescriptions: An International Review."
179   Cornford et al., "Electronic Prescribing in Hospitals—Challenges and Lessons Learned."
180   Author interview.
181   Author interview.
182   Ibid.
183   Areng, Liina, "Lilliputian States in Digital Affairs and Cyber Security," Tallinn Paper No. 4, NATO Cooperative Cyber Defence Centre of Excellence (2014).
184   Ibid.

CONCLUSION: MODELS FOR IMPLEMENTING E-PRESCRIPTIONS ACROSS THE EUROPEAN UNION

This study has shown that Estonia, the United Kingdom, Denmark, and Sweden implemented e-prescriptions with different starting positions and approaches in terms of the countries' size, timelines, structural features of the health systems, and implementation strategies. These country case studies revealed that e-prescriptions may have different benefits: economic benefits in terms of efficiency gains for prescribers and dispensers, enablement through transparency creation, and reduction of fraud and paper printing; health benefits in terms of reduced error rates, better accessibility to medication, adherence to physician recommendations, and opportunities for aggregate analyses in the health system; plus social benefits such as patient satisfaction with the health system, financial relief for society, and better care for the elderly.

At the same time, the measurable impact of e-prescriptions is often difficult to quantify and may differ from country to country, or even within a country. As Barber summarised: "The obvious question is 'does it work?' and that has three problems: 'does' in the sense that the evidence tends to be in the past; 'it,' because what is it—it is embodied in all sorts of different sociotechnical forms in different parts of the organisation; and 'work,' because it may be working for finance because it's good cost capture, but it's not working for the patient, or it's making the nurse's time much longer."[185] Consequently, benefits of e-prescriptions cannot easily be generalised across different contexts.

The differences in benefits may be rooted in how the countries implemented e-prescriptions in their different starting positions. Franklin remarked: "Countries or policymakers tend to assume that the benefits from one country or the issues from one country will automatically the same as in another country—and that's not necessarily the case. You can't really extrapolate from one country to another because the baseline systems are very different."[186] In a system with well-functioning manual processes, e-prescribing may not lead to substantial differences; furthermore, e-prescribing will have only limited impact if the sociotechnical system in which it is embedded does not work well. Consequently, the benefits of e-prescribing will be greatest for countries with rather dysfunctional existing prescribing processes,

but which use the introduction of e-prescriptions as an opportunity for properly redesigning their processes while also optimising the system, training their users well, and integrating e-prescribing with related services in the health system.

The case studies also showed that there is no single recipe for success. As reflected in the success factors around the degree of digital maturity in the health system and the country more generally as well as the trust and digital readiness of the population and workforce, several fundamental factors are rooted in the country's historical features. These are not specific to e-prescriptions, but rather in relation to their vision for digitisation and innovation, their commitment to rethinking service design in the process of moving to a digital society, and, closely related to that, cultural factors deeply engrained in the population, which drive acceptance and demand of the service. "It's a long history—you cannot do it from one day to another," as Johansen summarised.[187]

In that sense, none of the country case studies represents a single ideal model: none can simply be transferred to another country—especially countries with very different prerequisites and developments over the last decades. Kolte remarked: "It is really difficult to take one component out of the equation and say this is what you should learn. It's pretty much built on the Danish society."[188] This mainly refers to the people using the systems—prescribers, pharmacists, and patients—and their expectations and values based on the existing health system and previous experience with digitisation, but also to the organisations and their public and private ownership in the country's health system as a factor that fundamentally drives dynamics of adoption and benefit realisation.

Some success factors can be derived from the country case studies, however. First of all, uptake and benefit realisation depend on how well the processes around the system, and the system itself, have been designed. Equally important is how e-prescriptions are introduced: there needs to be some organisation taking the lead, setting the vision, and facilitating national standards to be implemented in health information systems, but also aligning all of these aspects with all associated stakeholders, who need to be incentivised to use the new system in one way or the other. Also, each country must have an appropriate implementation plan for rolling out the system.

There may be various ways of addressing these success factors in each country, because as Barber explained,

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185   Author interview.
186   Author interview.

187   Author interview.
188   Author interview.

"Most of these things, they are not disastrous, but you really need to know about them and anticipate them, particularly in national policy and in local rollout."[189] For example, there may not be one correct e-prescribing process nor one single best organisation to take over leadership for its nationwide introduction. Finally, some measures may also only work in certain organisational structures, such as the element of competition used to drive adoption among different regions in Sweden. In any case, it is important to see these success factors as an integrated whole, and to apply a holistic perspective in designing both the processes and the incentive structures for stakeholders.

Going forward, the next level of challenges arises with the aspiration to introduce cross-border e-prescriptions at a European level. While not the main focus of this research, the national experiences allow for some meta-level learnings: first, there needs to be leadership to harmonise legal structures, set up frameworks for interoperability between national systems, and define processes for different use cases, as is already done based on EU projects such as epSOS and EXPAND.

Second, benefits for the stakeholders from all member states need to be clearly elaborated, particularly for those with well-functioning e-prescription systems today, and may then be tested with single neighbouring countries first. Finally, e-prescriptions need to be embedded in the larger frame of cross-border services and the transition to a single digital market, with citizens expecting to be able to pick up their medication beyond national borders as a key driver of change.

As healthcare has been a fundamental member state competency from the beginning, however, it is important to continue facilitating the adoption of national health services, including e-prescriptions, across countries. This research has contributed to this aim by synthesising the evidence on the benefits of e-prescriptions, and working out the main success factors for their introduction and benefit realisation. Consequently, in the coming years, hopefully more countries will follow in the footsteps of Estonia, Sweden, Denmark, and the UK, while learning from these countries' positive and negative experiences with e-prescriptions.

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189   Author interview.