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HEALTH COMMITTEE****Health Working Papers****OECD Health Working Papers No. 114****METHODOLOGICAL DEVELOPMENT OF INTERNATIONAL MEASUREMENT OF  
ACUTE MYOCARDIAL INFARCTION 30-DAY MORTALITY RATES AT THE  
HOSPITAL LEVEL****Michael Padget\*, Nelly Biondi and Ian Brownwood\*****JEL classifications: C18, C13, I14**

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## *Abstract*

International quality measurement work is moving beyond the consideration of health system or national level variations to understand variations within countries and enable more meaningful cross-country comparison. Hospital performance is one key area where policy makers are increasing their focus on reducing variation, lifting the overall standards of care while minimizing the widespread differences in access and quality of care that are evident within health systems.

In 2014 the OECD launched the Hospital Performance Project to better understand performance across countries and strengthen international comparisons. From 2015-2018 the OECD developed a method for measuring hospital level acute myocardial infarction 30-day mortality for international comparison. The methodological development and pilot data collections undertaken over this time have resulted in robust and feasible approach to ongoing routine international hospital level data collections on AMI 30-day mortality rates with potential applications to other subnational level indicators. This paper discusses the development of this measurement including technical as well as practical aspects of collecting, displaying, and analysing such data.

## *Résumé*

Le travail de mesure de la qualité à l'échelle internationale va au-delà de la prise en compte des variations des systèmes de santé ou des niveaux nationaux pour comprendre les variations à l'intérieur des pays et permettre des comparaisons plus significatives entre pays. Le rendement des hôpitaux est l'un des principaux domaines où les décideurs se concentrent de plus en plus sur la réduction de la variation, en relevant les normes générales de soins tout en minimisant les différences généralisées en matière d'accès et de qualité des soins qui sont évidentes dans les systèmes de santé.

En 2014, l'OCDE a lancé le Projet sur la performance des hôpitaux afin de mieux comprendre la performance des hôpitaux dans les différents pays et de renforcer les comparaisons internationales. De 2015 à 2018, l'OCDE a déployé des efforts considérables pour mettre au point une méthode de mesure de la mortalité due à un infarctus aigu du myocarde de 30 jours au niveau hospitalier à des fins de comparaison internationale. Le développement méthodologique et les collectes pilotes de données entreprises au cours de cette période ont abouti à une approche solide et réalisable de la collecte systématique de données sur les taux de mortalité liés à l'IAM à 30 jours au niveau des hôpitaux internationaux, avec des applications potentielles à d'autres indicateurs au niveau sous-national. Le présent document traite de l'élaboration de cette mesure, y compris des aspects techniques et pratiques de la collecte, de l'affichage et de l'analyse de ces données.

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## PART ONE: SETTING THE SCENE

### 1.1. Introduction

1. This paper seeks to provide a reference to those looking to understand, and perhaps compare, the specific approach the OECD has taken to measuring hospital-level AMI 30-day mortality rates and to appreciate the key methodological challenges and practical choices made in order to establish a robust data collection aimed at facilitating meaningful international comparisons and enabling broad participation from across the 36 OECD member countries.
2. Hospital performance is of central policy relevance to OECD member countries given the scope and magnitude of resources devoted to providing hospital services and the value and concern the public places on access to high quality hospital care. Amidst reforms to further integrate acute care into the broader delivery system, the governance and accountability of hospitals remain priorities for governments, with national hospital performance measurement programmes, coupled to public reporting systems, evident in many OECD countries.
3. The Quality and Outcomes Programme of the OECD has well established routine data collections that include hospital performance-related indicators at the health system level and has consistently reported the variations observed in these indicators across countries, including AMI and stroke mortality and hip surgery process indicators.
4. International work is now moving beyond the consideration of health system level variations in hospital performance to ward a greater understanding of variations within countries. For example, ECHO (European Collaboration for Healthcare Optimization) <http://echo-health.eu/> and EuroHOPE (European Health Care Outcomes, Performance and Efficiency) <http://www.eurohope.info/> are two key European Commission funded international projects that have made significant contributions to the body of knowledge in this area in recent years, by bringing together data from multiple countries and advancing methodological approaches to enable robust comparison of hospital performance.
5. In late 2014, the OECD commenced oversight of a body of work on hospital performance with ambitions to gain an appreciation of the state of the art in hospital performance reporting across OECD countries and establish ongoing international data collections at the hospital level on key performance indicators.
6. During 2015-2017 considerable development work was undertaken, informed by a group of international methodology experts and a series of pilot data collections, in establishing an OECD international data collection on AMI 30-day case fatality rates reported at the hospital-level. This data collection provides a pipeline for collecting robust and comparable data from countries at a more granular level, enabling further insights on international variations in quality and outcomes of hospital care.
7. The first fruits of the OECD data collection efforts on hospital-level AMI 30-day mortality rates were published in the organisation's flagship publication *Health at a Glance 2017*. In publishing this material, it is recognised that the indicator definitions and methodological approach used to generate the indicator rates may vary from those used by other international initiatives and individual member countries. Different analytical methods can result in quite different indicator rates for and rankings of organisations and

countries, making direct comparison between rates problematic. The specific analytical method used by the OECD is one of several valid options considered during the indicator development work.

## 1.2. Guiding Principles

8. In order to develop the capacity to collect more granular international data on hospital performance and undertake international comparisons at the hospital level, the OECD recognised that considerable further methodological development of its existing national indicators was required, given the alignment of indicators at the hospital level with key organisational accountabilities within OECD member countries and the heightened impact of local patient casemix characteristics on hospital-level indicator rates.

9. The following principles guided the methodological development of the international data collection on hospital-level AMI 30-day case fatality rates:

### *Fit for Purpose*

10. Ensure the approach taken to methodological development is tailored to the individual indicator and is fit for the intended purpose.

11. Indicator development at the hospital level requires an individual approach for each indicator. The methodological requirements for indicators can vary according to intended use and level of aggregation (e.g. national, regional, hospital). For example, the risk standardisation required of an indicator for a clinical audit or assessment of hospital executive performance is likely to be more sophisticated than for general reporting of international variations.

12. This principal influenced the decision to focus on one indicator for development during 2015-16.

### *Balance of Objectives*

13. Balance the objectives by maximising participation by countries, while also promoting best practice approaches to indicator calculation.

14. The approach taken to indicator development strives to promote the ‘gold standard’ for the intended purpose at hand. However, health information infrastructures across the 36 member countries are evolving and are at different stages of development, varying their capacity to deliver on best practice indicator calculations. In this context, pursuance of broader participation and scope for international comparison, methodological compromises are required.

15. This principal underlies the current adoption of two different indicator calculation methods by the OECD Quality and Outcomes Programme, whereby one method relies on linked patient data (where patient records are linked and rates include deaths both in and outside the initial admission hospital) and the other on unlinked patient data (where no linkage takes place and rates count only deaths during the initial admission hospital). While calculations using linked patient data are considered methodologically more robust, not all countries have access to a unique patient identifier necessary to link patient records at this time.

16. This principal also influenced the decision to employ a methodological approach that relied largely on hospital administrative data, without consideration of the rich clinical data available to some countries to develop sophisticated risk standardisation of indicators.

### ***Evidence Based***

17. Place reliance on empirical evidence in garnering expert advice and guidance on key methodological issues.

18. Over the past 15 years the OECD has been establishing a suite of quality and outcome indicators for international data collection and comparison. The development of these indicators has been underpinned by a series of carefully specified pilot data collections to inform expert deliberations and decisions regarding ongoing methodological development.

19. This principal was applied during the development of the hospital-level AMI 30-Day Mortality Rate data collection. An international group of methodology experts (see Annex 1) were brought together to share conventional wisdom on key technical aspects of the indicator development and their deliberations and advice to the Working Group on Health Care Quality and Outcomes was informed by three pilot data collections over the two years of development. Each data collection was constructed to explore the feasibility and impact of specific methodological options.

### ***International Harmonisation***

20. Work towards harmonisation of methodological approaches to reporting hospital performance indicators at the international level.

21. As acknowledged earlier, different analytical methods can result in quite different indicator rates for and rankings of organisations and countries, making direct comparison between rates problematic. The specific analytical methods used for international comparisons are likely to differ from those used nationally by OECD member countries due to differences in intended purpose and access to data.

22. While valid methodological options and alternatives exist for calculating indicators for international comparison, active effort by the OECD and other international organisations is ongoing to bring about greater harmonisation to indicator specification and rationalisation of data collections processes. The European Commission funded a number of international projects over the last 3-5 years that have made significant advances in the development of hospital level indicator specification and data collection across a number of European countries.

23. This principle was fundamental to the development of the OECD hospital-level AMI 30-day Mortality indicator data collection, with clear recognition that there was no need to ‘reinvent the wheel’ but rather learn from the experiences of existing international initiatives and collaborate with them in seeking to harmonise methods and learnings into the future. The research and development being achieved through these initiatives, including the EuroHOPE, ECHO and EUBIROD projects, has been (and continues to be) particularly influential in shaping the methodological approach and data collection processes of the OECD at the hospital level.

### **1.3. Importance of indicators using linked data**

24. Many, but not all, of the 36 OECD countries have access to the use of a unique patient identifier to link patient data across health services and related databases. Over 20 countries contributing to the routine data collections of the Quality and Outcomes Programme of the OECD demonstrate the capacity to link patient records across hospitals



and years in national hospital administrative databases, with most of these countries able to also link this data with national death registries.

25. Over the last decade the OECD in collaboration with national experts and other international agencies has been developing international indicator specifications and calculation algorithms that require the ability to identify and track patients receiving hospital care and their outcomes. The patient centred nature of this approach is now broadly considered to be the gold standard in indicator calculation, based on the quality and outcome indicators developed and tested to date. For example, the OECD has already established an international indicator specification for calculating national rates of AMI 30-day mortality based on linked data, in addition to an existing specification that does not required the use of linked data.

26. The strengths of linked data-based calculation of indicators are particularly evident when considering quality and outcome indicators at the hospital level. For example:

#### ***Attribution of Outcomes***

27. By linking periods of hospitalisation for patients, where more than one hospital has been involved in an episode of care for a condition, a more purposeful and consistent approach to attribution of care outcomes can be achieved. For example, the valid comparison of outcomes of care associated with and without transfers a hospital transfers can more readily be achieved.

#### ***Systematic Bias***

28. Within a country and across countries, the average length of stay in a hospital can vary significantly. Where the outcome of interest is recorded during a hospitalisation, differences in the average length of hospital stay can systematically bias the data and skew performance measurement. By linking hospitalisations and hospital data to other data, the impact of differences in length of stay on indicator values can be removed.

#### ***Completeness***

29. Not all incidences of the hospital care outcome of interest occur during a hospitalisation. For example, to obtain a true representation of the occurrence of mortality after admission to hospital, both in hospital and out of hospital deaths need to be captured. By linking hospital data to death registry data all known deaths can be captured in an indicator calculation.

#### ***OECD's role***

30. The OECD has been encouraging member countries to strengthen the capacity and quality of their health information data systems over the last 5-7 years in recognition of the enormous benefits to health system performance measurement and patient care that can accrue from national data linkage, development of electronic longitudinal patient records and greater access to data for health care decision making.

31. The OECD's recent work on developing an international hospital level data collection on AMI 30-day mortality underlines once again the importance of greater development of and access to nationally linked hospital and related patient data.

#### 1.4. Existing National Indicator Specifications

32. The OECD Quality and Outcomes Programme routinely collects national level data for AMI 30-day mortality rates using both unlinked and linked data (see “Importance of Patient Based Indicators using linked data Calculation”).

33. The technical definitions utilised by countries to calculate these indicators during the OECD’s routine data collection on health care quality and outcome indicators in 2017 are set out below in Boxes 1 and 2. A previous specification for these national indications was used as the basis for developing the hospital-level AMI 30-day case fatality indicators. Some of the refinements adopted for the hospital-level indicator specifications were subsequently reflected in the 2017 national specifications set out in Boxes 1 and 2 (e.g. inclusion of only the last admission in the denominator count for the linked data-based calculation).

##### **Box 1. Acute Myocardial Infarction 30 Day Mortality using unlinked data**

Coverage: Patients aged 45 and older

Numerator: Number of deaths in the same hospital that occurred within 30 days of the admission date of the denominator cases.

Denominator: Number of admissions to hospital for acute non-elective (urgent) care with a primary diagnosis of acute myocardial infarction from 1 January to 31 December in the specified year. [AMI diagnostic codes upon separation: ICD-9 410 or ICD-10 I21, I22.]

Please note:

All admissions (including day cases) are to be counted in the denominator including admissions resulting a) in a transfer to another acute care facility (transfers out) and b) from a transfer from another acute care facility (transfers in).

The numerator is calculated by following up all denominator cases for up to 30 days, which will require access to data in the calendar year following the specified year.

**Box 2. Acute Myocardial Infarction 30 Day Mortality using linked data**

Coverage: Patients aged 45 and older

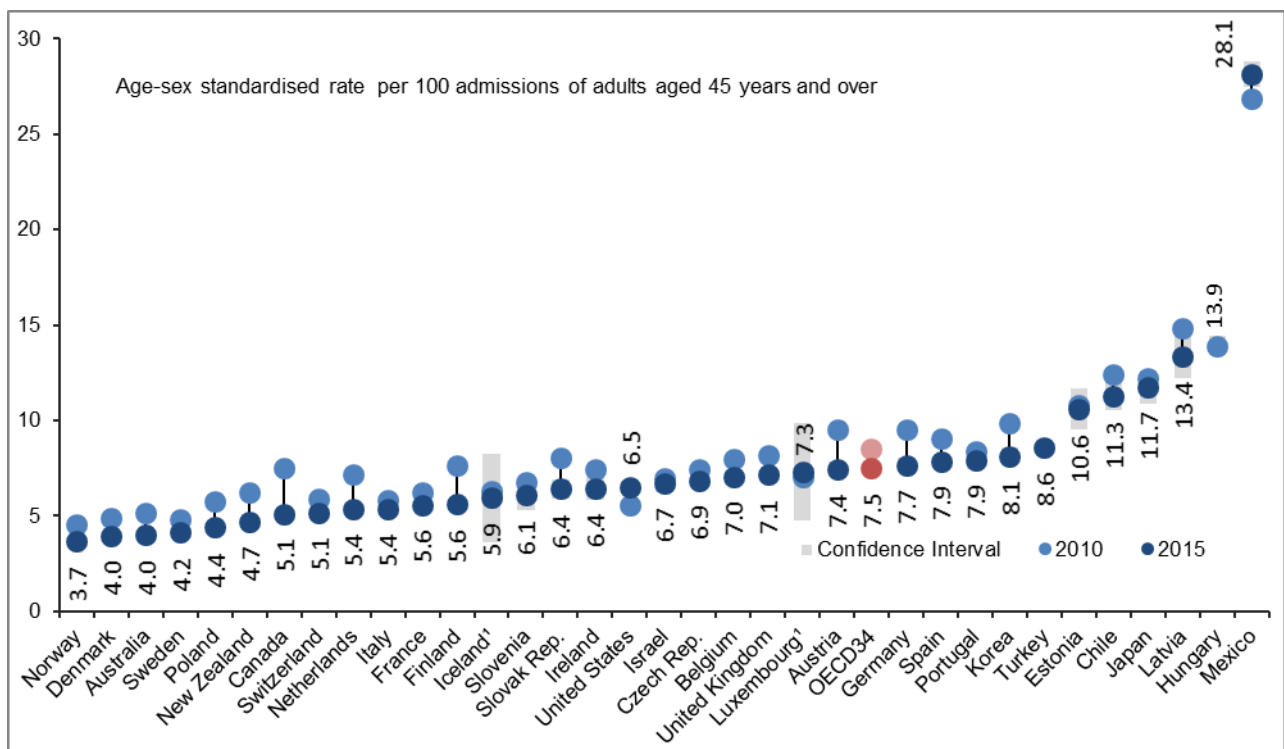
Numerator: Number of deaths in any hospital and out of hospital that occurred within 30 days of the admission date of the denominator cases.

Denominator: The last admission in the specified year for each patient admitted to hospital for acute non-elective (urgent) care with a principal diagnosis (PDx) of acute myocardial infarction from 1 January to 31 December in the specified year. [AMI diagnostic codes upon separation: ICD-9 410 or ICD-10 I21, I22.].

Please note only one admission per patient is to be counted in the denominator and the numerator is calculated by following up all denominator cases for up to 30 days, which will require access to data in the calendar year following the specified year.

34. The data received from countries and reported through the OECD flagship publication Health at a Glance 2017 for the calculation using unlinked data is presented in Figure 1.

**Figure 1. Thirty-day mortality after admission to hospital for AMI based on unlinked data, 2010 and 2015 (or nearest years)**

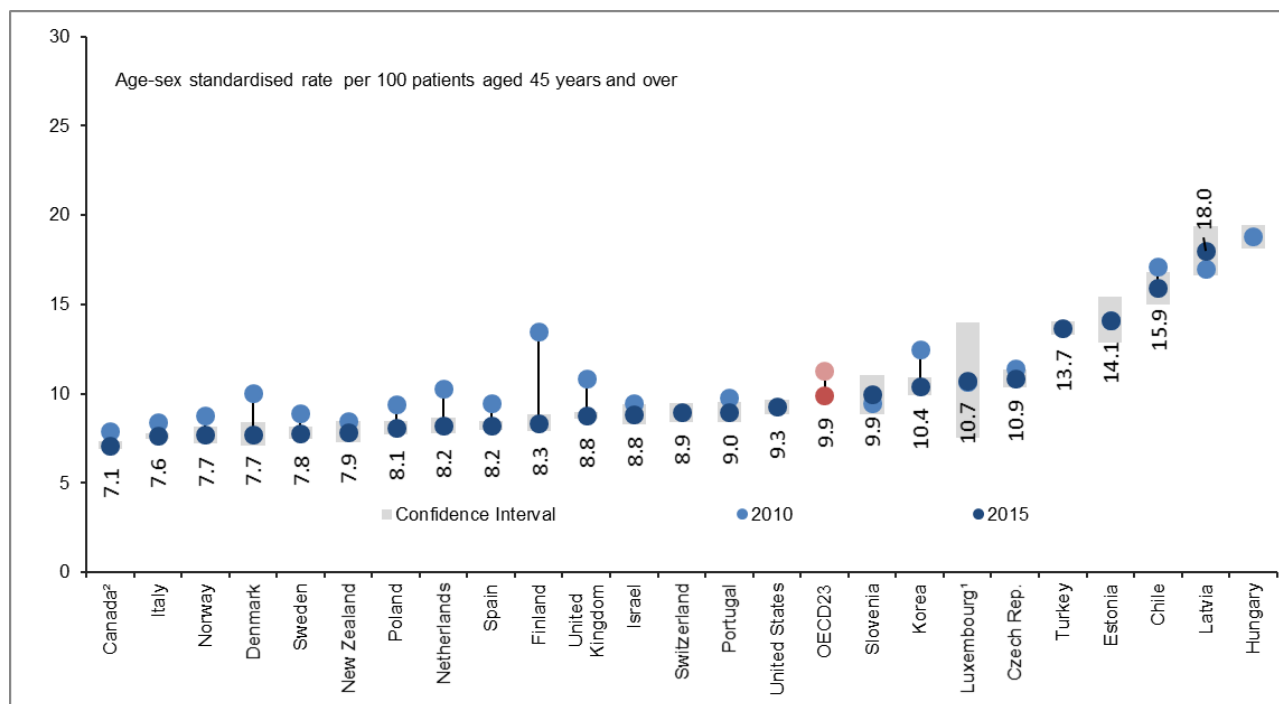


Note: 95% confidence intervals have been calculated for all countries, represented by grey areas. 1. Three-year average.

Source: OECD Health Statistics 2017.

35. Thirty five (35) countries were able to provide data for publication on this indicator, whereas only twenty four (24) countries were able to provide data for the calculation using linked data (See figure 2).

**Figure 2. Thirty-day mortality after admission to hospital for AMI based on linked data, 2010 and 2015 (or nearest years)**



Note: 95% confidence intervals have been calculated for all countries, represented by grey areas. 1. Three-year average. 2. Results for Canada do not include deaths outside of acute care hospitals.

Source: OECD Health Statistics 2017.

36. Both the rates using linked and unlinked data are indirectly age and sex standardised to the OECD 2010 population.

37. Mortality rates using linked data are higher than those using non-linked data. Whereas unlinked data calculations only detect deaths in-hospital, linked data are able to detect deaths inside and outside the hospital resulting in higher numerator values. Unlinked calculations count each hospital admission in the denominator while linked calculations may combine multiple admissions for the same patient into a single denominator case (see Figure 4).

38. Part One of this paper sets out the background, guiding principles and existing methodological basis for the development of the OECD international data collection on hospital level AMI 30-day mortality rates. Part Two highlights some of the key methodological challenges faced and choices made in developing the data collection on AMI 30-day mortality rates at the hospital level. Part Three provides a conclusion and summarizes the implications from this work for the ongoing development of international comparisons of hospital performance.

39. Information on the OECD's current specification for international measurement of AMI 30-day mortality rates at the hospital-level and detailed in the Annex.

## 2. PART TWO: KEY METHODOLOGICAL CHALLENGES AND CHOICES

40. Under the auspice of the OECD Working Group on Health Care Quality and Outcomes (formerly known as the Health Care Quality Indicator Expert Group), significant development work was undertaken during 2015-2016 by the OECD to establish a robust and feasible approach to collecting international hospital level data on AMI 30-day mortality rates. In order to responsibly and effectively address the methodological challenges and choices faced during this development exercise, in line with the guiding principles for this work, the OECD relied on three key sources of information and advice:

### *International Methodology Expert Advice*

41. Considerable methodological research and development of hospital level AMI 30-day mortality indicators has been undertaken at both national and international levels, particularly over the last 5-10 years. A number of key projects funded by the European Commission have progressed the evidence base and methodological development on key hospital clinical outcomes indicators.

42. For instance the EuroHOPE and ECHO projects have been able to access patient level data to explore and advance methodological issues related to hospital outcome indicator specification and risk standardisation in recent years. The EUBIROD project, in advancing international data availability and analysis on diabetes, established a data collection methodology which avoided the international collection and exchange of patient data through micro aggregation of key data strata.

43. In seeking to draw on this evidence base and the collective experiences of national indicator development efforts in countries like Australia, Canada, Israel, Italy, Japan, Korea, New Zealand, UK and US, a group of international methodology experts were brought together to consider the specifications of the pilot data collections and advice on further methodological refinements based on the subsequent data outputs (see Annex 1 for a list of participants in this group). This group's guidance provided the backbone for the methodological development of the OECD's approach and the basis for ongoing advice to the experts participating on the Working Group on Health Care Quality and Outcomes.

### *Pilot Data Collections*

44. A series of international pilot data collections were carried out at critical points during the consideration of various methodological options to inform decision-making.. In preparing for these data collections, the input from individual countries willing to test the data collection tools was invaluable. For example, researchers from Finland, Australia, Italy and New Zealand assisted in the development and tested the initial SAS programs for the AMI indicator calculations and provided helpful feedback on improvement.

### *OECD Member Country Oversight*

45. Expert oversight of the entire programme of work on hospital performance was provided by the Working Group on HCQO, including the HCQO Bureau. With national expert representation from the 36 OECD member countries, this group provided sound guidance and sense testing of progressive components of the overall approach. Their overall support of the pilot data collections, proposed approach and publication of early

results in Health at a Glance 2017 was pivotal in establishing the OECD hospital level AMI 30-day mortality indicator.

46. What follows is an illustrative overview of the key issues, evidence and decisions taken in developing the specific approach to measuring hospital-level AMI 30-day mortality rates adopted by the OECD. It is not intended to be an exhaustive account of the deliberations of the various experts over the development period or provide definitive evidence on decisions of best practice but should give the reader an appreciation of the key methodological challenges and practical decisions that are required to realise such a development in an international context.

47. The following sections seek to address the following key methodological questions faced by the OECD in developing the international data collection on hospital-level AMI 30-day mortality rates:

1. How did we approach the fundamental units of measurement?
2. How did we identify the indicator population?
3. How did we identify mortality in the indicator population?
4. How did we attribute performance?
5. How did we account for differences in patient casemix?
6. What standardisation approach did we use?
7. How was the reference population created?
8. How did we manage mortality rates in small hospitals?
9. How did we deal with issues of data exchange?
10. How did we graphically represent variations in rates?

### 2.1. **How did we approach the fundamental units of measurement?**

48. The fundamental units of measurement for the AMI 30-day mortality rates required careful identification and definition. OECD experience in international outcome indicator development over the past 15 years clearly demonstrates that significant variation can exist in the way countries describe and codify key structures, processes and outcomes of care in their health data systems, resulting in the need for significant effort to map and align these differences to enable valid international comparisons.

49. In approaching the specification of hospital level AMI 30-day mortality rates, the following units of measurement were defined: hospital, hospital admission and hospital episode. For the purpose of the pilot data collections carried out during the development of the indicator the following definitions were employed:

#### ***Hospital***

50. A hospital was defined as a single separate organisational entity that provides admitted patient care. It is recognised that some hospitals may be located on more than one campus, in which case countries were requested consolidate data from each of these locations for the purposes of OECD data collection. On the other hand some hospital campuses have more than one hospital, in which case countries were requested to report data from each hospital separately.

51. The governance of services in some countries results in the aggregation of hospitals into corporations, trusts, groups, chains, or networks. For the purposes of the pilot data collections the term hospital referred to the single separate organisational entities within these governance arrangements.

52. Practical approaches to identifying a hospital entity from aggregations of hospital entities were suggested, including consideration of whether the entity is the lowest level of organisation that has in itself a) a recognised unique hospital name b) a separate chief executive and/or board of management c) requirements for separately reporting routine administrative data and/or d) been generally recognised as a single hospital entity by the relevant administering authority.

53. Care was taken in defining a hospital given early evidence from a preliminary data collection confirmed that the variation of indicator rates within countries is affected by the level of hospital aggregation, with greater levels of aggregation (for example at a regional or trust level) associated with lower levels of variation.

54. Supplementary data provided by countries during the pilot data collections indicated that while most countries complied with the OECD's definition of a hospital, in some countries a single hospital identifier in the data reported could represent multiple hospitals on one campus and/or the aggregation of multiple hospitals on separate campuses. For example, data from the UK was provided at the trust level where multiple hospitals are aggregated for the purposes of reporting. This situation was specifically noted in the subsequent publication of data in *Health at a Glance 2017*.

### *Scope*

55. The scope of the pilot data collections for the calculation of the AMI 30-day mortality rate indicators was specified as all government (including public) and non-government (including private) hospitals in each country that provide acute care to patients. From the indicator and supplementary data received from countries participating in the pilot data collections it was evident that significant variation existed in the

- Scope and coverage of public and private hospitals
- Size and distribution of hospitals

56. While most countries indicated the data provided was nationally representative, only a few countries (Canada, Finland, Korea, Latvia, Sweden) reported they provided data with complete or near complete coverage of both public and private hospitals sectors (see Table 1).

**Table 1. Data representativeness of countries participating in the pilot data collection, 2016**

Country	Hospitals in Admission Dataset	Hospitals in Patient Database	Representative*	Public/Private	% of total acute hospitals**
CAN	570	569	Yes	Public/Private	92%
CHL	231	226	Yes	Public/Private	-
DNK	29	29	Yes	Public/Private	40%
EST	19	19	Yes	Public/Private	86%
FIN	21	21	Yes	Public/Private	91%
IRE	34	-	Yes	Public	62%
ISR	26	26	-	-	-
ITA	824	837	Yes	Public/Private	68%
KOR	305	302	Yes	Public/Private	91%
LVA	22	22	Yes	Public/Private	100%
MEX	128	376	No	Private	3%
MLT	2	2	Yes	Public	50%
SVN	14	13	Yes	Public/Private	82%
SGP	5	5	Yes	Public	63%
SWE	66	66	Yes	Public/Private	100%
U.K.***	209	196	Yes	Public/Private	-

\*Representativeness was assessed by each country and communicated to the OECD as part of the Sources and Methods questionnaire

\*\*calculated as hospitals in admission dataset divided by total acute care hospitals listed in sources and methods questionnaire. Not all hospital may have AMI activity.

\*\*\*Only data from England included.

57. The AMI caseload and distribution of hospitals showed marked variations across countries, with a few countries (Canada, Korea) reporting that around 50% of the total hospitals in their data had fewer than 50 AMI admissions in the three year reference period. Whereas other countries such as Denmark, Finland, Israel and Sweden reported either very few on no hospitals with fewer than 50 AMI admissions in the three year reference period (see Table 2).

**Table 2. Number of hospitals by AMI admissions based on unlinked data, 2013-2015**

AMI admissions	CAN	DNK	FIN	ISR	IRE	ITA	KOR	LVA	NOR	SVN	SWE	UK*
>300	151	21	21	21	20	336	67	6	35	3	62	142
50-300	158	7	0	5	8	160	83	11	17	7	4	8
<50	261	1	0	0	6	328	155	5	2	4	0	59

\*Only data from England included.

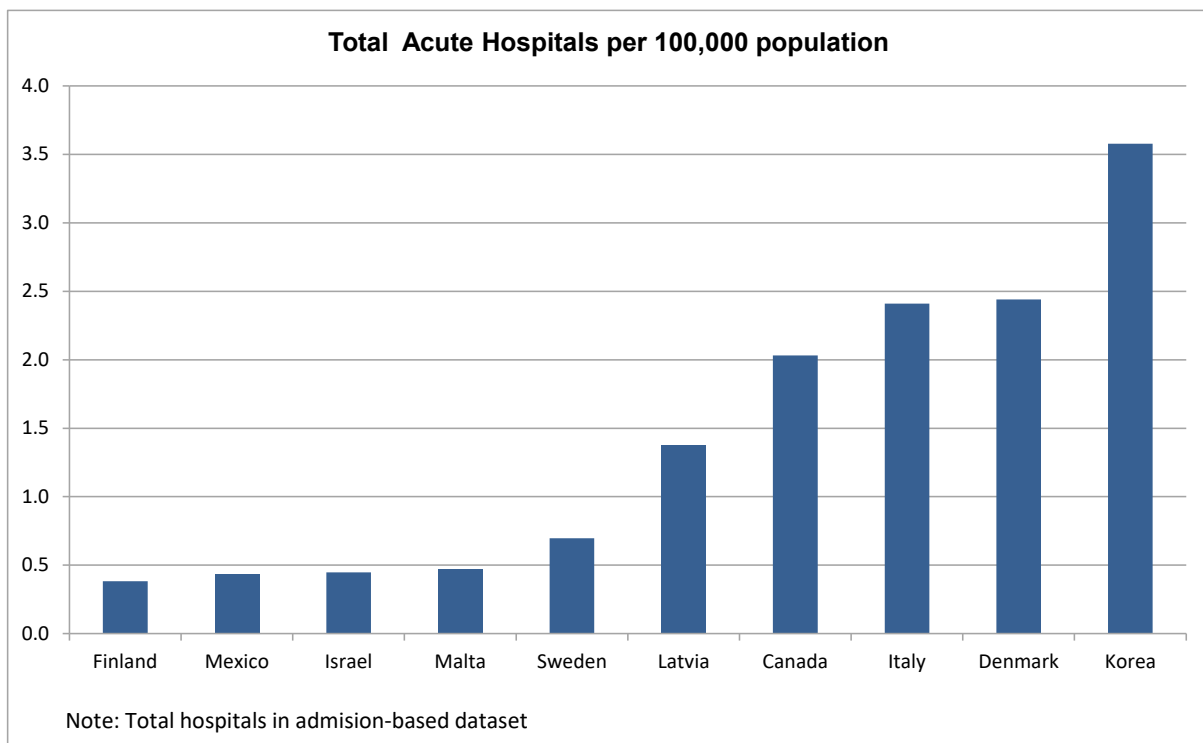
58. Upon review and follow up with countries, there are clear indications that countries like Finland and Korea may have adopted quite different interpretations on the scope of hospitals to be included for the indicator calculations. For example, Finland only included the university and central hospitals, including major regional hospitals in the 20 districts across the country. While patients suffering an AMI may first have an admission at one of 200 health centres or regional hospitals in Finland, before being transferred to one of the



20 university or central hospitals, no acute hospital care is deemed to be provided outside of the smaller group of major hospitals. Conversely, in Korea it would appear that all the community clinics providing acute care to patients were considered in scope for the pilot data collection.

59. Figure 3 presents the total number of hospitals included in the datasets provided by countries during the pilot data collection in 2016 as a rate per 100,000 population. While this data reflects both variations in scope and coverage of hospitals (for example, Mexico only provided data on 4% of the total hospitals in the country), the situation for Finland and Korea is clearly demonstrated. Interestingly, if all 200 health centres in Finland were included in the indicator dataset then they would have an acute hospital rate of 4 per 100,000, commensurate to that for Korea at 3.6 per 100,000.

**Figure 3. Acute hospitals included in pilot data collection per 100,000 population, 2016**



60. The precise impact of the apparent cross country differences in the definition of what constitutes a hospital and the scope and coverage of acute hospitals in the data provided to the OECD during the pilot data collections is unclear. Although initial analysis of the relationship between hospital characteristics (ownership, academic status, specialisation, throughput, location) and AMI mortality rates undertaken by the OECD generated broadly inconclusive results, an inverse relationship between AMI caseload and mortality was observed and found to be statistically significant. This would indicate that the exclusions of hospitals with smaller caseloads from AMI 30-day mortality calculations could result in marginally lower national rates.

### ***Hospital Admission***

61. A hospital admission was defined as a period of hospital care from the date of formal admission to a hospital to the date of formal discharge from the same hospital.

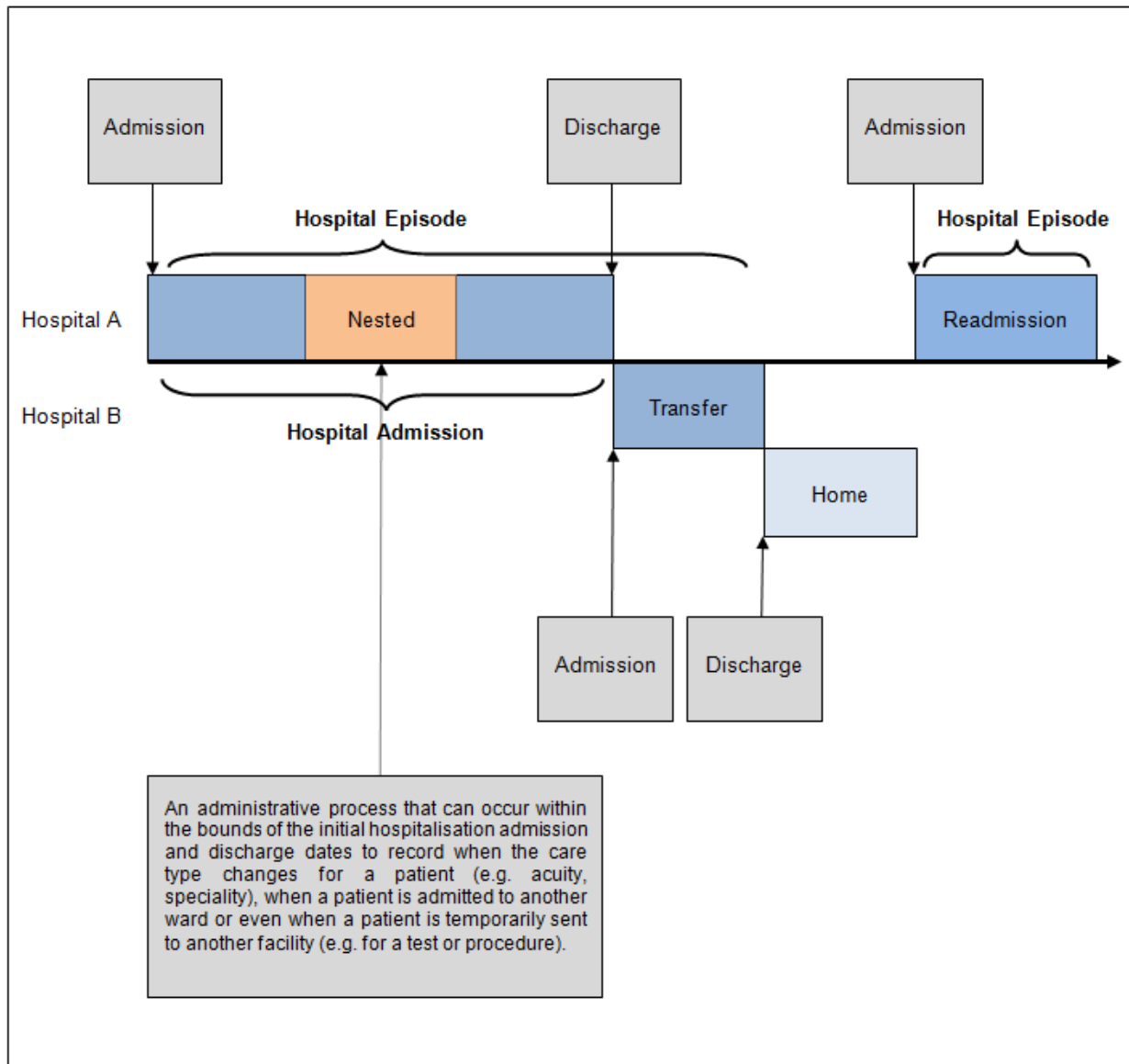
Administrative processes that result in the discharge and admission of a patient within the bounds of the initial hospitalisation admission and discharge dates are referred to as ‘nested admissions’ and are not considered hospital admissions for the purposes of this data collection.

### ***Hospital Episode***

62. A hospital episode was defined as a period of hospitalised care from the date of admission to a hospital to the date of discharge home (or to a nursing home or long term care) or death. This definition excludes the separate counting of any hospital admissions that occurred during this period that either resulted from transferring a patient from one hospital to another or from a record for a nested admission.

63. A schematic representation of the structure and relationship between hospital admissions and hospital episodes is provided at Figure 4. The distinction between hospital admissions and hospital episodes is important given the two different indicator calculation methods for the AMI 30-day mortality rate adopted by the OECD.

Figure 4. Structure and Relationship between Hospital Admissions and Hospital Episodes



64. Through the linking of hospital data, the calculations using linked data enable the construction of hospital episodes. This enabled more deliberate and consistent identification of the first acute hospital providing acute care to a patient after an AMI, improving identification of outcomes with 30 days and the attribution of performance

65. Intelligence garnered from supplementary data provided by countries through routine OECD data collections on health care quality and outcome indicators and the pilot data collections undertaken during the AMI 30-day mortality indicator development identified the risk that the lowest unit of measurement of hospital care reported by countries may vary significantly. For example, in Australia an episode of care can represent multiple administrative admissions or nested admissions whereby the clinical care of a patient changes within one admission. Whereas in the UK, while a hospital spell may also include multiple nested admissions they can also include leave from hospital for up to 28 days.

66. To manage the risk of countries reporting different units of measurement for a hospital admission or hospital episode, the OECD developed SAS code that when applied to country databases consistently built the units of measurement from the records contained in each database. In some countries, this resulted in the consolidation of records to create a hospital admission whereas in other countries only one record was required to construct an admission, as defined by the OECD (see Figure 4).

## 2.2. How did we identify the indicator population?

67. The annex of this paper specifies the indicator (denominator) population for the each of the two calculations of the AMI 30-day mortality indicator. The rationale for the common inclusion and exclusion criteria for both the unlinked and linked data calculations include:

- Urgent acute care – the indicator population is restricted to patients receiving urgent, non-elective acute care to ensure only those hospitalisations that occurred immediately after suffering an AMI were captured, rather than any planned re-admission for follow up care.
- Aged 45 years and over – while other international constructions of this indicator include a broader specification of the adult population (for example, EuroHOPE included people 18 years and over), the OECD indicator specification limits the population to people aged 45 years and over.

Truncation of the adult population is undertaken to create a measurement focus on that strata of the adult population with higher incidence on AMI, and higher risk of subsequent mortality. It is considered this can result in enhanced comparability and reliability of indicators rates.

- Same day hospitalisations – patients who are admitted and discharged home on the same day are excluded from the population. These cases indicate coding issues, given it is unlikely that a course of urgent acute care for an AMI can be completed in one day.

### *Specific denominator criteria*

68. Specific criteria are also specified for the denominator population for each of the two indicator calculations:

- Calculation using unlinked data – all non-elective acute admissions in the reference period with a principal diagnosis of AMI
- Calculation using linked data – the last non-elective acute hospital episode in the reference period that involves an admission with a principal diagnosis of AMI

69. In deciding on the specific inclusion and exclusion criteria for each calculation, the OECD and collaborating experts considered the feasibility and impact of alternative criteria through a pilot data collection in 2016. The options considered explored:

- Treatment of Hospital Transfers

In some countries, patients admitted to hospital after suffering an AMI are routinely transferred to another acute hospital within the first day or so for further acute care (for example, to carry out procedures during a percutaneous coronary intervention). Where this occurs, the counting of all admissions in the denominator calculation of

the AMI 30-day mortality indicator may systematically bias indicator values downwards (i.e. inflate denominator counts) in comparison to other countries where such transfer arrangements are not in place.

In order to remove the impact of this potential source of bias and improve the comparability of the indicator of the AMI 30-day mortality using unlinked data, a variation of the denominator population was explored where admissions that resulted in a transfer to another acute hospital within two days were excluded.

- Selection of Hospital Episode

In contrast to the situation for the indicator based on unlinked data, the indicator based on linked data selects only one admission (within a hospital episode) for each patient during the reference period to be included in the denominator. By linking data through the use of a unique patient identifier, many countries are able to identify all the admissions for each patient during a specified period. Then based on an explicit criterion, one hospital episode can be consistently selected for inclusion in the denominator population.

While this allows for a more purposeful identification of denominator population and reduces the risk of systematic bias that is associated with the unlinked data calculation, there still remains a question over which hospital episode to select when a patient has multiple AMI hospitalisations during and/or prior to the reference period.

### *Options for selecting the hospital episode*

70. The basis and rationale for selecting the single hospital episode in linked data-based calculations of AMI 30-day mortality indicators can vary. For example, in some studies (for example, the EuroHOPE project) the emphasis has been on identifying the outcome of patients after hospitalisation for their first AMI, including measurement of any subsequent re-admissions and longer term mortality rates. This is a longitudinal or cohort approach that seeks to place emphasis on the comparison of fatality rates amongst patients with a similar clinical history of AMI. It has been demonstrated that the mortality rate for patients with a history of AMI is higher than those experiencing their first AMI.

71. This approach results in any hospital episodes occurring within a reference period, where the patient has had a prior hospitalisation for an AMI within a specified period, being excluded from the denominator population. This approach consequently excludes from the calculation of the indicator rates any deaths that occurred within 30 days of any subsequent AMI admission in the reference period. By not capturing these deaths, the reliability of indicator rates can be undermined as numerator counts for this already rare event are further reduced.

72. Conversely, in other studies the emphasis has been on capturing all AMI case fatalities within 30 days in the reference period. This is achieved by selecting the last AMI hospital episode in the reference period, regardless of whether the patient has had a previous AMI admission or not. While the AMI history of a patient can be taken into account through risk-adjustment, similar to other patient characteristics, there is a view that this approach can mask the quality of care associated with previous admissions. That is, by taking into account the outcome attributed to a hospital treating the patient during the last AMI hospital episode, the indicator calculation ignores the hospital responsible for successfully treating the patient for a previous AMI. So while this approach ensures all deaths are captured

during the reference period, some experts assert it also has the potential for introducing bias through the non-recognition of prior positive outcomes.

73. A third approach to selecting the reference AMI hospital episode, used in some studies (for example, Hospital Compare in the US), is to randomly select an episode where more than one qualifying episode exists during the reference period. While this approach results in each episode being given an equal chance of being included in the denominator, it is unlikely to capture all mortality cases in a reference period or completely avoid the bias in comparing hospitals with caseloads of patients who have had multiple AMI hospital episodes, particularly smaller hospitals. It may also be more difficult to explain or understand the outcomes of this approach.

74. The New South Wales (NSW) Bureau of Health Information in Australia recently compared congestive heart failure 30-day mortality rates in the state of NSW using the last episode of care and a randomised episode of care (BHI, p.53, 2017). While the results confirmed that randomisation reduced the number of identified mortality cases, resulting in a reduction in mortality rates from 15% to 12%, the impact on the relative performance of hospitals in relation to their status as statistically higher or lower than expected was marginal. Consequently, the BHI continues to specify the last episode of care in their specification of the denominator population for the measurement of AMI 30-day mortality rates.

75. The OECD compared the feasibility and impact of using two options:

- a) first AMI hospital episode within 365 days
- b) last AMI hospital episode within the reference period.

76. While other studies have used a longer lookback periods (up to five years) to identify prior hospitalisations and isolate patients with their first AMI hospital episode within the reference period, the experts working with the OECD advised that a one year lookback could be clinically justified and may be more feasible than longer look back periods. Given the reference period for the OECD AMI 30-day mortality indicator already requires aggregation of data over three years, it was considered that extended lookback periods may impose excessive data requirements on some countries. It is noted that the EuroHOPE project incorporated a 1 year lookback period in their international work in this area. However, this situation did result in the possibility of more than one hospital episode qualifying for inclusion in the denominator population.

### ***Results from the pilot data collection***

77. The OECD sought to assess the feasibility and impact of the different treatment of hospital transfers using an unlinked data based calculation and the different selection of hospital episode for the linked data-based calculation through a pilot data collection carried out in 2016. Data was collected from 14 participating countries (Australia (New South Wales), Canada, Chile, Denmark, Finland, Israel, Italy, Korea, Latvia, Mexico, Norway, Singapore, Sweden) on AMI 30-day mortality rates which allowed the comparison on the following variants of the indicator:

*Unlinked data-based calculation:*

- Including all qualifying admissions

- Excluding short stay transfers

*Linked data-based calculation*

- Only first hospital episode within 365 days
- Only last hospital episode in reference period

Impact on mortality rates

78. The impact on the denominator, numerator and crude rates of these variants of the indicator are summarized at Table 3 and presented at Figure 5. It is noted that linked data-based calculations have a differential impact on both the numerator and denominator of the AMI 30-day mortality indicator compared with the unlinked data-based calculations. By essentially only counting each patient once during the reference period, the patient based calculations results in consistently lower denominator values.

79. Conversely, by linking hospital administrative datasets to mortality registers, the linked data-based calculations capture all mortality (both in and out of hospital) and consequently result in consistently higher numerator values. In addition to reflecting the true mortality rate within 30 days, the linked data-based calculation reduces the risk of bias related to differences in hospital length of stay across hospitals that is associated with unlinked data-based calculation methods.

80. The impact of excluding short stay admissions resulting in a hospital transfer in the OECD pilot data collection resulted in a 10% reduction in the denominator count and 11% reduction in the crude rate for the unlinked data-based calculation of the AMI 30-day mortality rates. Whereas the impact of counting the last hospital episode rather than the first hospital episode within 365 days in the reference period for the linked data-based calculation resulted in a 7% elevation of the indicator rate.

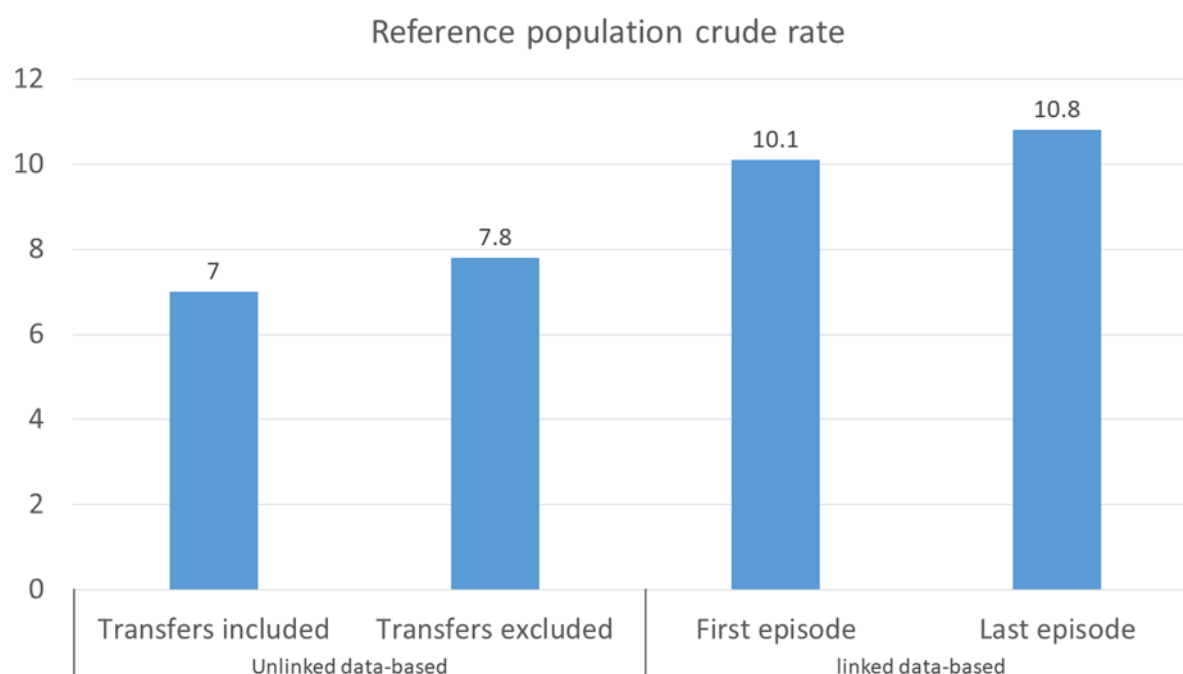
**Table 3. Unlinked and linked data-based crude AMI 30-day mortality rates per 100, 000 hospitalisations using pooled data.**

	Transfers Included	Transfers Excluded	First Episode	Last Episode
Numerator	30,487	30,486	38,163	40,992
Denominator	432,149	387,767	377,572	379,503
Crude Rate	7	7.8	10.1	10.8
Numerator	-	0%	25%	34%
Denominator	-	-10%	-13%	-12%
Crude Rate	-	11%	44%	54%

Source: OECD Pilot Hospital Performance Data Collection 2016

81. Although the difference between each variant within the admission and patient based calculations was in the vicinity of 10%, the combined impact across the unlinked data-based and patient based calculations resulted in crude rates ranging from 7.0 to 10.8 per 100 hospitalisations. The crude linked data-based rate where only the last hospital episode was counted was over 50% higher than the unlinked data-based rate where all admissions were counted.

**Figure 5. Unlinked and linked data-based crude AMI 30-day mortality rates using pooled data.**



Source: Source: OECD Pilot Hospital Performance Data Collection 2016

#### Impact on relative performance

82. In addition to considering the impact of different methodological approaches to identifying the indicator population on the overall level of the crude AMI 30-day mortality rates, it is important to consider the implications of these approaches for assessing relative performance of hospital systems across countries.

83. Spearman's rank correlation helps assess the strength of the relationship between the rankings of two variables. The correlation coefficient (Spearman's rho) between two variables will be high when observations have a similar rank between the two variables, and low when observations have a dissimilar rank between the two variables.

84. Using data from 10 countries participating in the OECD pilot data collection in 2016, the Spearman's rho when comparing the two unlinked data-based calculation variants (with and without inclusion of hospital transfers) was 0.99, giving some indication that the ranking of national crude rates of AMI 30-day mortality are not particularly sensitive to this methodological choice.

85. Figure 6 illustrates the ranking of the 10 countries (i.e. Norway, Denmark, Sweden, Israel, Korea, Italy, Canada, Finland, Malta, Latvia) based on the crude AMI 30-day mortality rates for the unlinked data-based calculation with and without the inclusion of short stay hospital transfers. The ranking of only two countries (i.e. Sweden and Israel) were affected by the methodological choice to include or exclude short stay hospital transfers.



**Figure 6. Country ranking using unlinked data-based calculations with and without transfers**

Rank	Country	With		Rank	Country	Without
1	NOR	4.4	→	1	NOR	5.4
2	DNK	5.1	→	2	DNK	6.4
3	SWE	5.8	↔	3	ISR	6.5
4	ISR	6.2	↔	4	SWE	6.7
5	KOR	6.6	→	5	KOR	6.9
6	ITA	6.7	→	6	ITA	7.2
7	CAN	7.2	→	7	CAN	8.2
8	FIN	8.1	→	8	FIN	8.6
9	MLT	9.9	→	9	MLT	10.0
10	LVA	12.1	→	10	LVA	12.5

*Source:* Source: OECD Pilot Hospital Performance Data Collection 2016

86. However, while a strong relationship between ranks of the unlinked data-based calculation variants was demonstrated, the relationship between unlinked data-based and linked data-based calculations was weak. The Spearman's rho when comparing the unlinked data-based calculation (with transfers) with the linked data-based calculation (last hospital episode) was only 0.21. Figure 7 illustrates that the ranking of most of the 10 countries were influenced by the choice of calculation method, with some country rankings shifting markedly (e.g. Canada, Denmark, Korea).

**Figure 7. Country ranking using admission (without transfers) and patient (last episode) based calculations**

Rank	Country	Without		Rank	Country	Last
1	NOR	6.2		1	CAN	7.4
2	DNK	6.7		2	ITA	8.7
3	KOR	7.1		3	ISR	8.8
4	SWE	8.1		4	NOR	8.9
5	ISR	8.1		5	SWE	9.0
6	ITA	9.6		6	DNK	9.5
7	FIN	10.2		7	KOR	10.1
8	MLT	11.2		8	MLT	10.3
9	CAN	11.4		9	FIN	12.0
10	LVA	20.3		10	LVA	34.0

Source: Source: OECD Pilot Hospital Performance Data Collection 2016

87. The observations, both in terms of the impact on crude AMI 30-day mortality rates and the relative performance of countries, underline the

- sensitivity of measurement outcomes to various methodological decisions when specifying hospital performance indicators, and
- heightened need for consistency in calculation of these indicators across countries to enable robust international comparisons.

88. Furthermore, given the methodological improvements in indicator calculation afforded by linking data across hospitals and with death records, the importance of further development of health information infrastructure in some countries is amplified in order to expand international comparisons using ‘gold standard’ methods.

### ***Practical decisions made***

89. The methodological decisions taken by the OECD, informed by advice from the methodological experts, involved a balancing of objectives in line with the guiding principles outlined in Part One of this paper. On the one hand, the conventional wisdom of the experts supported the exclusive use of the linked data-based indicator calculation given it represents a more robust methodological approach. While on the other hand, maximising participation of OECD and collaborating countries in comparing health system performance is recognised as an important objective and not all countries are currently able to generate AMI 30-day mortality rates using a linked data-based calculation method, given their inability to link datasets and report data at the national level. Consequently, the OECD continues to collect and, where appropriate, report AMI 30 day mortality rates using both unlinked data-based and linked data-based calculations.

Unlinked data-based calculation

90. In selecting the variant of the unlinked data-based calculation to take forward in this development work, the OECD needed to again balance the objectives of methodological rigour with broad participation by OECD and collaborating countries.

91. The ability to reliably identify hospital transfers is not universal across OECD countries, with a significant number of countries participating in the Data Collection indicating that it is not possible to exclude all hospital admissions resulting in a transfer to (transfers-out) or from (transfers-in) another hospital in their indicator calculations. While it is evident more countries can reliably record transfers-out than transfers-in, in some countries, discharge destination is still not available or sufficiently specified in their hospital datasets.

92. Where a country has a unique patient identifier (UPI) available in their hospital database but still provided data for the unlinked data-based calculation, they were able to identify transfers using the UPI and admission and discharge date fields rather than a discharge status field in their database. The SAS code provided by the OECD to assist countries with indicator calculations during the pilot data collection in May 2016 applied data steps to enable an approach using linked data to be followed, where relevant.

93. The overall results of the OECD pilot data collection in 2016 revealed that while a few countries employed the use of the UPI and others have a reliable variable to measure transfers, approximately a third of the countries participating in the data collection were not able to reliably identify hospital transfers. The implication of this situation was that in order to remove the impact of this potential source of bias and improve the comparability of the unlinked data-based calculation of the AMI 30-day mortality indicator, a significant number of countries would be need to be excluded from participation. Furthermore, given it was previously agreed that the overriding objective of retaining an unlinked data-based calculation was to maximise country participation, and the impact on country rankings may be low, it was considered that the specification of this calculation of the indicator should include short stay transfers.

Linked data-based calculation

94. In selecting the variant of the linked data-based calculation to take forward in this development work, the methodological experts providing advice to the OECD weighed up the merits of using the first hospital episode within 365 days and the last episode in calculating the AMI 30-day mortality rates. Whilst it was broadly agreed that both variants were valid, on the basis of the data outcomes of the OECD pilot data collection (which confirmed the higher capture of mortality cases using last episode), the exclusive focus on 30 day mortality (rather than also considering more distal outcomes, such as 90 day mortality rates) and the ability to risk standardise the mortality rates for previous AMI, the experts supported the specification of the last hospital episode for this calculation of the indicator.

**2.3. How did we identify mortality in the indicator population?**

95. The basis for identifying cases where the patient died within 30-days after being admitted to hospital after suffering an AMI has previously been discussed in this paper. Using an unlinked data-based calculation, the numerator cases are identified by considering the discharge status of the patient within 30 days. Given the principal diagnosis of a patient admitted to hospital after an AMI will be recorded in the hospital administrative database

as an AMI, the actual cause of death may not be readily identified through the database. While it is feasible that patients admitted to acute care after an AMI may die in hospital within 30 days from another cause, this has not generally been taken into account in indicator constructions for routine data collection based on hospital administrative datasets.

96. The use of a linked data-based calculation of the AMI 30-day mortality rate provides the potential to more readily explore the cause of death of a patient admitted after an AMI, given the numerator cases are identified from national death statistics rather than the discharge status in the hospital administrative dataset. However, there is often a significant time lag between the recording of the event of a death in national registries and the confirmation of the cause of death. For example, in Australia preliminary cause of death data only becomes available after about two and a half years from the end of a financial year (BHI, 2017, p.63). This situation brings into question the relative utility of potentially more valid indications of the causes of death and the provision of more timely and actionable metrics.

97. A study by the New South Wales Bureau of Health Information (BHI) in Australia reanalysed AMI 30-day mortality cohorts using cause of death data (BHI, 2017). Two main findings resulted from this work:

1. The vast majority of deaths (68-81%) were attributed to the same ICD-10 chapter for both principal diagnosis (hospital administrative records) and underlying cause of death (death statistics).
2. The percentage of deaths attributed to the same ICD-10 chapter for both principal and underlying cause of death was only slightly higher (13% points) among patients who died in hospital than among patients who died after discharge.

98. The BHI conclude that the 30-day window reduces the likelihood of including unrelated deaths when applying linked data-based calculations and that the event of death (rather than the cause of death) is sufficiently specific for use in calculating risk standardised mortality rate (BHI, 2017, p.63). In alignment with this form of reasoning, the OECD specification of the hospital level AMI 30-day mortality indicator relies on the recording of the event of death (rather than cause of death) in national hospital administrative datasets for the unlinked data-based calculation and in national death statistics for the linked data-based calculation.

#### 2.4. How did we attribute performance?

99. Methodological considerations related to the identification of the indicator population (denominator) and the outcome measure (numerator), have implications for the attribution of performance to hospitals. For example, the unlinked data-based calculation of AMI 30-day mortality attributes the outcome to the acute hospital where the patient dies, regardless of whether the patient received acute care at another hospital prior to being transferred for ongoing treatment within the same episode of care.

100. The situation for the linked data-based calculation is quite different. Here the OECD definition attributes the outcome to the first hospital in the episode of care. This means that even if the care provided by the first hospital is only of brief duration compared to the care provided by another hospital during the episode of care, the death of a patient within 30 days in any location is attributed to the first hospital. Clearly, where more than one hospital is involved in the care of a patient after suffering an AMI, the choice of indicator calculation method will have an impact of performance for individual hospitals.

101. It is noted that the EuroHOPE project has explored a linked data-based calculation variant that attributes mortality to the hospital that was highest in the hierarchy of hospitals ('hospital in charge') that treated the patient during the first seven days of the episode of care. In ascending order these include general or local hospitals, central or regional hospitals, specialist hospitals and university hospitals. This variant avoids the attribution of performance to the initial hospital when routine transfers are made early in the episode to more specialised hospitals (linked data-based calculation) or the last hospital where the patient may have been transferred after substantial acute care in one or more other hospitals (Unlinked data-based calculation).

102. A recent study of EuroHOPE and OECD methodological approaches to the measurement of AMI 30-day mortality rates was undertaken based on a dedicated data collection across Finland, Hungary, Italy, Norway and Sweden (Bridge Health, 2017). This study allowed the comparison of risk standardised AMI 30-day mortality rates from both the OECD and EuroHOPE approaches where the first hospital is attributed the outcome and from the EuroHOPE approach where the hospital in charge is attributed the outcome.

103. Table 4 provides the Spearman's rank correlation coefficients for the OECD and EuroHOPE approaches based on all the hospitals included in the data from the five countries. In comparing the OECD and EuroHOPE linked data-based calculations, a rho of at least 0.91 is observed indicating a strong relationship between ranks. However, when these two methods are each compared with the EuroHOPE linked data-based calculation where the hospital in charge is attributed the outcome (see EuroHOPE, hierarchy. M1, M2, M3 at Table 4) then lower rho values are observed, ranging from 0.80-0.89.

**Table 4. Spearman’s rank correlation coefficients for OECD and EuroHope approaches to measurement AMI 30-day mortality rates based on data from Finland, Hungary, Italy, Norway and Sweden**

Model	OECD Patient, direct	OECD Patient, indirect	OECD Adm, direct	OECD Adm, indirect	EuroHOPE, hierarchy M1	EuroHOPE, hierarchy M2	EuroHOPE, hierarchy M3	EuroHOPE, first M1	EuroHOPE, first M2	EuroHOPE, first M3
OECD Patient-based, direct	1.0000									
OECD Patient-based, indirect	0.9497*	1.0000								
OECD Admission-based, direct	0.8096*	0.7922*	1.0000							
OECD Admission-based, indirect	0.7554*	0.7813*	0.9622*	1.0000						
EuroHOPE, hier. M1	0.8695*	0.8031*	0.6456*	0.5871*	1.0000					
EuroHOPE, hier. M2	0.8825*	0.8191*	0.6638*	0.6031*	0.9940*	1.0000				
EuroHOPE, hier. M3	0.8738*	0.8115*	0.7017*	0.6426*	0.9896*	0.9937*	1.0000			
EuroHOPE, first M1	0.9601*	0.9056*	0.7196*	0.6550*	0.8838*	0.8904*	0.8740*	1.0000		
EuroHOPE, first M2	0.9621*	0.9122*	0.7300*	0.6675*	0.8691*	0.8843*	0.8673*	0.9946*	1.0000	
EuroHOPE, first M3	0.9669*	0.9170*	0.7926*	0.7318*	0.8719*	0.8865*	0.8838*	0.9839*	0.9887*	1.0000

*Note: direct: direct standardization. Indirect: indirect standardization. Patient: using linked data, Adm: using unlinked data, Hier/hierarchy: attributing mortality to the “highest” hospital in the hierarchy if multiple hospital involved in patient care episode. First: attributing mortality to the first hospital in the care episode. M1: adjusted for age and sex. M2: adjust for age, sex, length of stay in the hospital in the previous year, disease specific comorbidities based on primary and secondary diagnoses. M3: similar to M2 with comorbidities also based on medication purchases.*

*Source: Bridge Health, 2017.*

104. While clinical debate continues to exist regarding which of the hospitals (where there are multiple) providing acute care to a patient after suffering an AMI should be attributed the outcome of that patient, the choice of hospital specified in the AMI 30-day mortality indicator would appear to make a difference in the ranking of hospital performance.

### ***Practical decisions made***

105. While this valid alternative existed for the OECD, the attribution of performance adopted for the OECD specification of the hospital level AMI 30-day mortality indicators lies with the last hospital with the unlinked data-based calculation and the first hospital with the linked data-based calculation.

## **2.5. How did we account for differences in patient casemix?**

106. While careful specification of the units of measurement, the indicator population and the basis for identifying and attributing outcomes is important in developing a robust international hospital level data collection on AMI 30-day mortality rates, particular attention is required in identifying and controlling for confounding factors that can unfairly distort comparisons of hospital performance. While explanatory factors for AMI outcomes related to the care of the patient should not be used to adjust indicator rates across hospitals,

key differences in the risk profile of patients treated by hospitals should be taken into account, where feasible and important.

107. Contemporary approaches to risk standardisation of AMI 30-day mortality rates at the hospital level can include a range of patient demographic and clinical risk factors many of which are not recorded in hospital administrative datasets. For example, in Korea risk factors taken into account for assessing hospital performance in AMI care include Killip class (which categories patients into severity of heart failure and risk of 30-day mortality), time required to reach an emergency room after symptoms were first detected, use of an ambulance, body mass index, serum creatinine, initial blood pressure, initial pulse, ejection fraction, the number of blood vessels invaded, cardiogenic shock, EKG diagnosis (not anterior STEMI, anterior STEMI, left bundle branch block, NSTEMI) and previous stroke.

108. In a recent comparison of hospital variations in AMI care and outcome between Sweden and United Kingdom (Chung et al., 2015), registry data was used take in to account multiple patient factors including demographic factors (age, sex, year of hospital admission), risk factors (smoking, history of diabetes and hypertension), severity of acute myocardial infarction (troponin I or T concentration, systolic blood pressure and heart rate at admission to hospital, and cardiac arrest); history of previous heart failure, cerebrovascular disease, and acute myocardial infarction; and procedure and drug use before admission (antiplatelet treatment with aspirin, clopidogrel, or both; previous percutaneous coronary intervention and coronary artery bypass graft).

#### ***Patient risk variables used***

109. Early decision-making in the development of the OECD approach to an international hospital level data collection on AMI 30-day mortality rates confirmed that the identification and selection of patient risk factors would be confined to those that are able to be routinely generated from the national hospital administrative datasets of OECD countries. It was considered that access to clinical risk variables akin to those collected in national registries would not be feasible for most countries. Further, where relevant national clinical data would be available, there would be additional concerns over the consistency of the data collected.

110. The group of methodology experts broadly agreed during initial deliberations in 2015 that a feasible and valid set of risk variables would include at a minimum:

- *Age and sex of the patient*

The existing OECD national indicator specifications for AMI 30-day mortality are risk standardised for age and sex and are considered to be important risk factors for AMI mortality at the hospital level.

- *Existence of high-risk patient comorbidity*

There are recognised pre-existing health conditions that predispose patients to a greater risk of death after an AMI.

- *Type of infarction the patient has experienced*

A STEMI or ST-elevation myocardial infarction is caused by a sudden complete blockage of a coronary artery. A non-STEMI infarction is usually caused by a severely narrowed artery but the artery is usually not completely blocked. Clinical evidence shows that the probability of mortality of STEMI and NSTEMI cases varies significantly.

- *Evidence of a previous AMI*

Evidence of a previous AMI was introduced as an additional risk variable to strengthen the risk standardisation of the variant of the linked data-based calculation where the last hospital episode of the reference period would be captured in the denominator count. This decision was taken given it has been demonstrated that the mortality rates for patients with a history of AMI is higher than those experiencing their first AMI.

111. It was noted that most of these variables were included in the broader set of variables utilised for risk standardisation of the AMI 30-day mortality indicator under the ECHO (unlinked data-based calculations) and EuroHOPE (linked data-based calculations) projects.

### ***Specification of the risk variables***

112. The follow section sets out the specification of the risk variables included in the OECD pilot data collection on AMI 30-day mortality rates in 2016:

- *Age and sex of the patient.*

Age classes for the data collection were specified as:

- 45-64 years
- 65-85 years
- 85+ years

- *Existence of high-risk patient comorbidity.*

113. A number of valid approaches to measuring patient comorbidity were identified for the AMI 30-day mortality indicator including:

- Validated indices with a history of extensive use in national and international studies, including the Exihauser Comorbidity Index and the Charlson Comorbidity Index.
- Purpose specific approaches developed for particular national or international studies, including the NSW Bureau of Health Information and the EuroHOPE project.

114. After some deliberation the methodology experts were broadly supportive of the use of either the Exihauser or the Charlson Comorbidity Index. The OECD adopted the use of the Charlson Index for use in the development of the AMI 30-day mortality data collection on the basis of practical considerations of actionability, including:

- Reported relative ease of use of the Charlson Index compared with alternatives
- Relatively higher existing use of the Charlson Index in participating OECD countries

115. A revised version of the Charlson Index (Quan H, Li B, Couris CM, et al., 2011) was adopted that specifies 12 comorbidities each with a weight which is then used to construct a score from 0-24. The comorbidities can be identified from the diagnosis fields of relevant patient records in national hospital administrative datasets. The relevant diagnosis codes are set out in Table 5.



**Table 5. ICD 9 and ICD 10 Codes for Calculating the Charlson Index**

<b>Comorbidities</b>	<b>ICD-10-WHO</b>	<b>ICD-9-CM</b>
Congestive heart failure	I09.9, I11.0, I13.0, I13.2, I25.5, I42.0, I42.5-I42.9, I43.x, I50.x, P29.0	398.91, 402.01, 402.11, 402.91, 404.01, 404.03, 404.11, 404.13, 404.91, 404.93, 425.4-425.9, 428.x
Dementia	F00.x-F03.x, F05.1, G30.x, G31.1	290.x, 294.1, 331.2
Chronic pulmonary disease	I27.8, I27.9, J40.x-J47.x, J60.x-J67.x, J68.4, J70.1, J70.3	416.8, 416.9, 490.x-505.x, 506.4, 508.1, 508.8
Rheumatic disease	M05.x, M06.x, M31.5, M32.x-M34.x, M35.1, M35.3, M36.0	446.5, 710.0-710.4, 714.0-714.2, 714.8, 725.x
Mild liver disease	B18.x, K70.0-K70.3, K70.9, K71.3-K71.5, K71.7, K73.x, K74.x, K76.0, K76.2-K76.4, K76.8, K76.9, Z94.4	070.22, 070.23, 070.32, 070.33, 070.44, 070.54, 070.6, 070.9, 570.x, 571.x, 573.3, 573.4, 573.8, 573.9, V42.7
Diabetes with chronic complication	E10.2-E10.5, E10.7, E11.2-E11.5, E11.7, E12.2-E12.5, E12.7, E13.2-E13.5, E13.7, E14.2-E14.5, E14.7	250.4-250.7
Hemiplegia or paraplegia	G04.1, G11.4, G80.1, G80.2, G81.x, G82.x, G83.0-G83.4, G83.9	334.1, 342.x, 343.x, 344.0-344.6, 344.9
Renal disease	I12.0, I13.1, N03.2-N03.7, N05.2-N05.7, N18.x, N19.x, N25.0, Z49.0-Z49.2, Z94.0, Z99.2	403.01, 403.11, 403.91, 404.02, 404.03, 404.12, 404.13, 404.92, 404.93, 582.x, 583.0-583.7, 585.x, 586.x, 588.0, V42.0, V45.1, V56.x
Any malignancy, including lymphoma and leukaemia, except malignant neoplasm of skin	C00.x-C26.x, C30.x-C34.x, C37.x-C41.x, C43.x, C45.x-C58.x, C60.x-C76.x, C81.x-C85.x, C88.x, C90.x-C97.x	140.x-172.x, 174.x-195.8, 200.x-208.x, 238.6
Moderate or severe liver disease	I85.0, I85.9, I86.4, I98.2, K70.4, K71.1, K72.1, K72.9, K76.5, K76.6, K76.7	456.0-456.2, 572.2-572.8
Metastatic solid tumour	C77.x-C80.x	196.x-199.x
AIDS/HIV	B20.x-B22.x, B24.x	042.x-044.x

Source: Quan, Sundararajan, Halfon et al, 2015

116. Calculation of the Charlson score for the unlinked data-based calculation was based on the secondary diagnoses fields of the reference admission. Whereas for the linked data-based calculation, the secondary diagnoses of the qualifying admission in the reference hospital episode and the primary and secondary diagnoses of any hospital admission

(regardless of acuity or urgency) in the previous 365 days was able to be considered to calculate the Charlson score.

117. For each relevant diagnosis code found in the relevant diagnosis field the corresponding weight or score was applied. This weight was only applied once, if in the event a qualifying diagnosis was identified more than once using the linked data-based methodology. The weight for each identified code was then added together to create the total score.

- *Type of infarction the patient has experienced.*

118. STEMI status can be identified in the principal diagnosis field of the reference admission for ICD-9 and ICD-10. Table 6 reflects the approach taken by the EuroHOPE (2012, p.5) project to identify STEMI status and was used as a guide for countries where an alternative protocol had yet to be established.

**Table 6. ICD 9 and ICD-10 Code Lists for Identifying STEMI Status**

Status	ICD-9	ICD-10
STEMI	410.0, 410.1, 410.2, 410.3, 410.4, 410.5, 410.6, (410.72) 410.8 and (410.92) depending on the site of the infarction.	I21.0, I21.1, I21.2, I21.3, I22
NSTEMI	410.7 exclude if 5 <sup>th</sup> digit is 2	I21.4
STEMI Unspecified	410.9 exclude if 5 <sup>th</sup> digit is 2	I21.9

- *Evidence of previous AMI*

119. The linked data-based calculation of the AMI case fatality rates where the last hospital episode of the reference period is captured in the denominator count included a previous AMI variable in the risk standardisation model.

- Variable Definition: any admission of a patient with AMI coded in a PDx and/or SDx field within the previous 365 days of the reference AMI admission
- Variable values: Yes/No

### ***Results from the pilot data collection***

120. Data from pilot data collections allowed comparison of the following combinations of the risk factors:

- Model 0: Crude rates
- Model 1: Age and sex standardised rates
- Model 2: Age, sex and STEMI status standardised rates
- Model 3: Age, sex and comorbidity standardised rates
- Model 4: Age, sex STEMI status and comorbidity standardised rates
- Model 5: Age, sex STEMI status, comorbidity and previous AMI standardised rates.

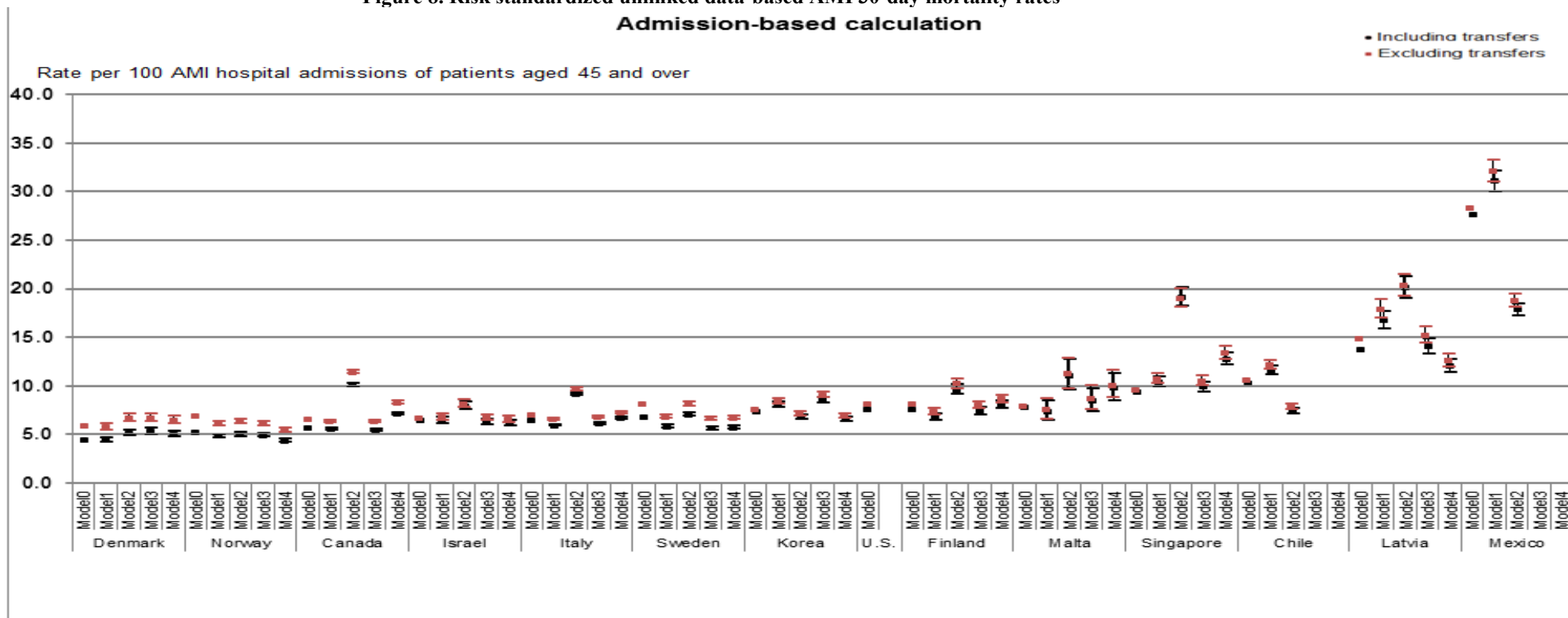
Note this model was only applied to the linked data-based calculation where the last hospital episode of the reference period is captured in the denominator count.

121. The chosen method for standardisation for the pilot data collection was indirect standardisation. From the pooled data file an ordinary logistic regression model with covariates was undertaken in order to estimate the risk specific coefficients that served as the reference population coefficients. These coefficients were then applied to the risk structure of the hospital populations to generate an expected number of deaths. The observed number of deaths was then compared with the expected and expressed as a mortality ratio (observed/expected). The risk standardised mortality rates were calculated by multiplying the mortality ratio with the crude mortality rate of the reference population.

122. The reference population for the pilot data collection was created in such a way that the pooled hospital data from each country had an equal influence on the reference population. This required the weighting of the data from countries. This approach to creating the reference population was employed to ensure alignment with the existing convention for creating and presenting OECD averages and for risk standardisation of existing health indicators.

123. National crude and risk standardised rates were calculated for each of the variants of the unlinked data-based (see Figure 8) and linked data-based (see Figure 9) calculations of the AMI 30-day mortality indicator from the data of the 14 participating countries.

**Figure 8. Risk standardized unlinked data-based AMI 30-day mortality rates**  
**Admission-based calculation**

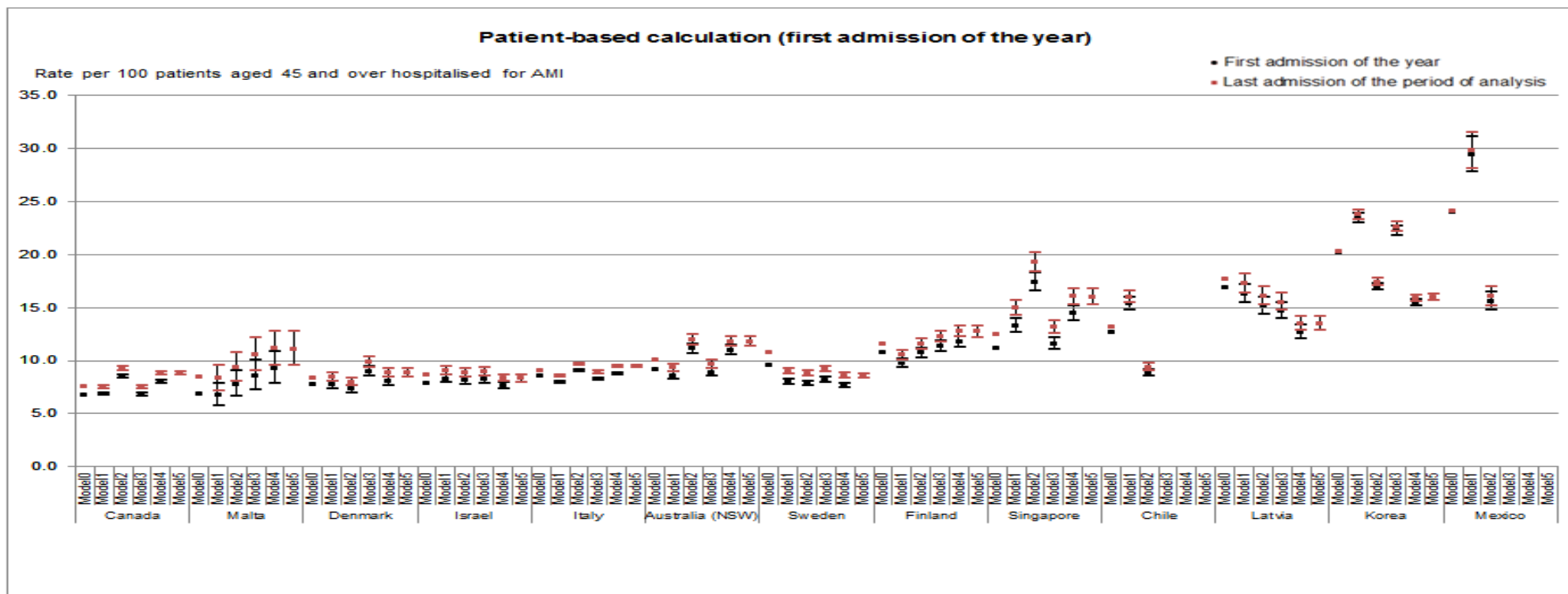


<b>Model 0</b>	<b>Crude Rates</b>
<b>Model 1</b>	<b>Age/Sex adjusted rates</b>
<b>Model 2</b>	<b>Age/sex, STEMI status adjusted rates</b>
<b>Model 3</b>	<b>Age/sex, comorbidity adjusted rates</b>
<b>Model 4</b>	<b>Age/sex, STEMI, comorbidity adjusted rates</b>

*Note:* Graph shows point estimates along with 95% confidence intervals for each model respectively. Admission-based: unlinked data.  
*Source:* OECD Pilot Hospital Performance Data Collection 2016

124. What was evident from the risk standardised AMI 30-day fatality rates generated from the OECD pilot data collection in 2016 was that the impact of different combinations of risk variables varied across countries both in terms of the direction of the effect and the magnitude of the effect. This applied to both the unlinked data-based calculation (see Figure 8) and the linked data-based calculation (see Figure 9).

Figure 9. Risk standardised linked data-based AMI 30-day mortality rates



<b>Model 0</b>	<b>Crude Rates</b>
<b>Model 1</b>	<b>Age/sex adjusted rates</b>
<b>Model 2</b>	<b>Age/sex, STEMI status adjusted rates</b>
<b>Model 3</b>	<b>Age/sex, comorbidity adjusted rates</b>
<b>Model 4</b>	<b>Age/sex, STEMI, comorbidity adjusted rates</b>
<b>Model 5</b>	<b>Age/sex, STEMI, comorbidity, previous AMI adjusted rates</b>

Note: Graph shows point estimates along with 95% confidence intervals for each model respectively. Patient-based: linked data-based.  
 Source: OECD Pilot Hospital Performance Data Collection 2016

### *Further consideration of the comorbidity variable*

125. When specifying patient comorbidity as a risk variable for AMI mortality, the methodology experts were aware of the inherent issues related to differences in secondary diagnosis coding depth and quality across participating countries. While it was expected that the Charlson scores would be influenced by the secondary coding depth of each hospital, broad support was given to inclusion of the variable given the important role comorbidity plays in elevating the risk of mortality after an AMI.

126. Supplementary data was collected during the OECD pilot data collection in 2016 on the average number of secondary diagnosis codes for each hospital to assess if there was a discernible relationship with the Charlson scores and whether or not the use of both primary and secondary diagnoses codes for any hospital admission in the previous 365 days under the patient based calculation made a significant difference.

127. Table 7 presents the comorbidity scores for the linked data-based calculation of the AMI 30-day mortality indicator, reflecting the score based on the secondary diagnosis coding of the reference hospital episode only and the score including the 365 day look back, allowing consideration of both principal diagnosis and secondary diagnosis codes recorded for any admission of a patient in that period. The results indicate that for countries with modest secondary coding depth, the inclusion of a 365 day lookback significantly increases the Charlson score, ranging from approximately 10-25%. It is noted that the rates did not change for Malta and only a marginal change was reported for Israel. This may be partially explained by low rates of prior admission for patients from the two hospitals in Malta and the high capture of comorbidity during the reference hospital episode given the strong coding depth reported for Israel.

**Table 7. Charlson scores and average secondary diagnosis coding depth for the linked data-based calculation of the AMI 30-day mortality indicator.**

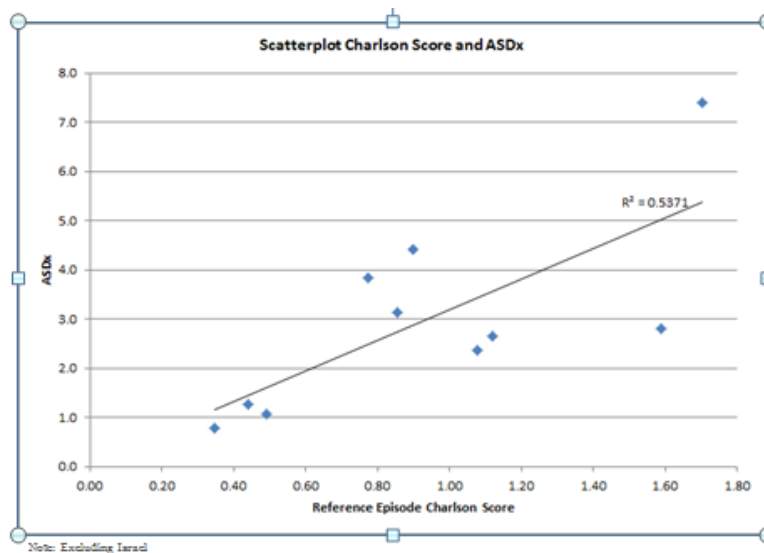
Country	Reference Episode Only	Including 365 day lookback	& change	ASDX
Malta	0.35	0.35	0	0.8
Finland	0.44	0.55	24	1.3
Denmark	0.49	0.61	24	1.1
Australia (NSW)	0.77	0.95	23	3.8
Canada	0.85	0.96	12	3.1
Israel	0.96	0.97	1	10.1
Sweden	0.9	1	11	4.4
Latvia	1.12	1.23	9	2.7
Italy	1.08	1.34	24	2.4
Norway	1.59	1.79	13	2.8
Korea	1.7	2.03	19	74

*Note:* ASDX: average secondary diagnosis coding depth

*Source:* OECD Pilot Hospital Performance Data Collection 2016

128. Figure 10 plots the average secondary diagnosis depth of participating countries with the Charlson score based on the secondary diagnosis coding of the reference hospital episode only. There is an indication from the data that greater coding depth is associated with higher comorbidity scores.

**Figure 10. Scatterplot of Charlson scores based on reference hospital episode for patient based calculation of AMI 20-day mortality indicator and average number of secondary diagnosis**



Note: ASDx: average second diagnosis

Source: OECD Pilot Hospital Performance Data Collection 2016

129. This association was further confirmed by the data provided by countries participating in a subsequent OECD pilot data collection in 2017 (see Table 8), where a four-level specification for comorbidity scoring was utilised instead of the two-level specification utilised in the 2016 pilot data collection. While the introduction of additional levels of specification provided scope for greater differentiation of comorbidity scores across countries, the impact of secondary diagnosis coding depth remained consistent. As secondary diagnosis coding depth increased, so did the percentage of patients in the highest co-morbidity category.

130. A number of potential solutions to this issue have been considered, including methods for adjusting co-morbidity scores for secondary diagnosis coding depth in countries. These methods included a technique previously used to adjust the postoperative complication indicators in the OECD set of patient safety indicators. This method used regression techniques to adjust the indicator rates by secondary diagnosis depth, taking into account specific country effects when creating adjustment coefficients (Drösler et al. 2012). This method proved to be impractical in this context given the co-morbidity score acts as an input to the calculation of AMI 30-day mortality rates and the methodology experts considered this would create the risk of introducing additional bias. The use of country effects was also considered problematic as it may prevent certain countries from participating, particularly those who were not included in the reference population. An effective approach to adjusting the Charlson scores was not identified and the methodology experts concluded that further research and development is merited on this issue.



**Table 8. Co-morbidity category & average secondary diagnosis by country (unlinked data-based calculation)**

	& of patient in highest co-morbidity category	Average number of secondary diagnoses per patient
Malta	0.78	0.7
Denmark	1.4	0.8
Finland	1.45	1.2
Italy	5.8	2.2
Latvia	7.1	2.9
Ireland	5.8	3.4
Canada	9.9	3.8
Slovenia	9.16	4.1
Sweden	9.2	4.4
Australia	9.18	5.2
Korea	13.2	5.6
Israel	13.15	7.2

Source: OECD Pilot Hospital Performance Data Collection 2017

131. While the methodology experts acknowledged that significant variation in secondary coding depth exists across countries and there is an apparent influence of coding depth on the Charlson scores, they considered that face validity of a comorbidity variable justified its ongoing inclusion in the specification of the AMI 30-day mortality indicators. It was considered that the higher Charlson scores associated with the linked data-based calculations may alleviate, to some extent, the coding effects for countries with modest coding depth.

132. The OECD has subsequently adopted the use of unadjusted Charlson scores for the calculation of risk standardised AMI 30day mortality rates with plans to acknowledge the implications of this approach alongside any planned publication of the data.

#### ***Further consideration of the STEMI status variable***

133. The treatment of STEMI Unspecified cases in the calculation of the risk adjusted rates had not been confirmed prior to the pilot data collection. Previous studies had identified the potential for introducing bias in the statistical modelling given the number, heterogeneity and higher mortality rate of STEMI Unspecified cases. However, it was unclear how to treat these cases in the OECD international data collection without first considering the quality and outcome of data related to these cases across participating countries.

134. The results from the OECD pilot data collection in 2016 confirmed that the proportion and mortality rate of non-STEMI, STEMI and STEMI not specified cases varies substantially (see Table 9), underlining the importance of including STEMI status as a risk variable in the calculation of risk standardised AMI 30-day mortality rates. The proportion of STEMI cases that died was nearly 90% higher than non-STEMI cases. But perhaps what was more striking was the high proportion of total cases recorded as STEMI not specified and the high proportion of cases that died (14.4%), nearly twice that of STEMI cases.

135. While STEMI not specified cases consistently exhibited a substantially higher mortality rates than STEMI and non-STEMI cases across participating countries (see Figure 11), the magnitude of the STEMI not specified rates varied enormously across countries relative to STEMI and non-STEMI rates. For example, in Norway, Korea, Latvia and Israel

STEMI not specified rates were less than twice the rates of STEMI cases whereas for Italy, Canada and Malta the rates were more than three times the rates of STEMI cases.

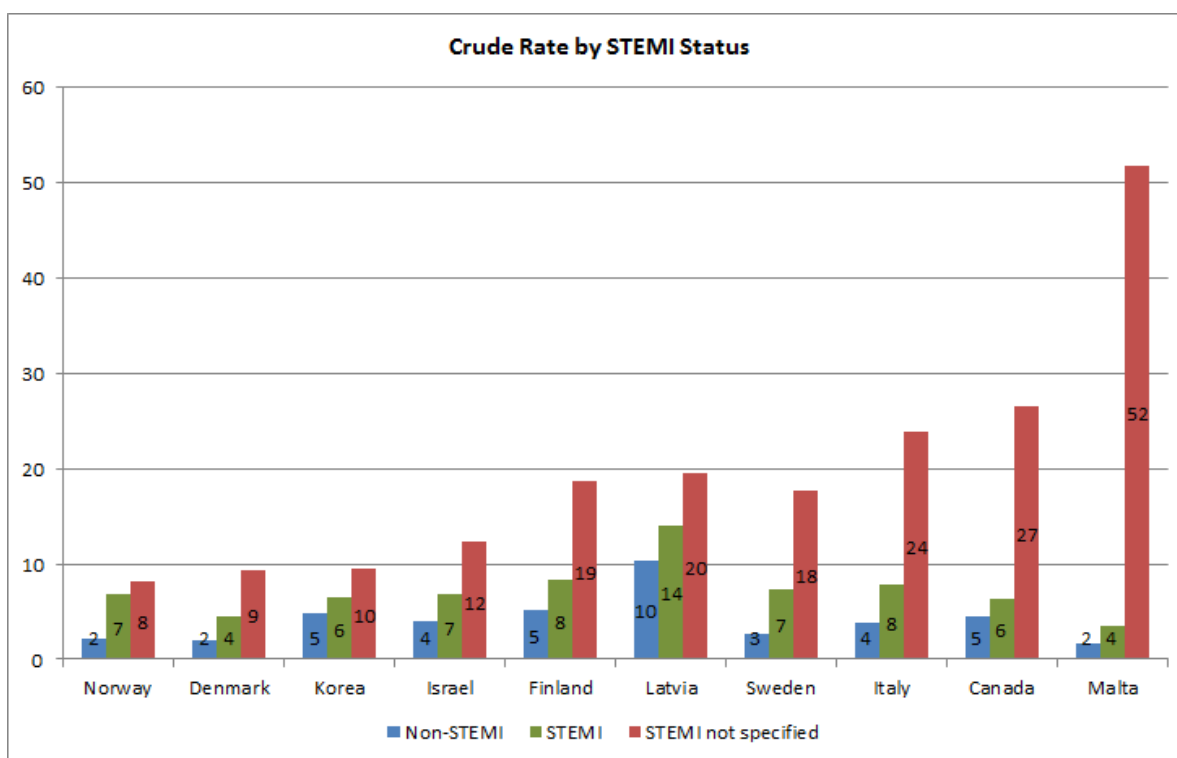
**Table 9. Proportion of AMI admissions by STEMI status and crude mortality rate**

type of AMI	N	% total	% died
Non-STEMI	384009	51.2	3.9
STEMI	283591	37.8	7.4
STEMI non specified	82793	11	14.4
<b>Total</b>	<b>750393</b>	<b>100</b>	<b>6.4</b>

Note: data pooled across 11 countries

Source: OECD Pilot Hospital Performance Data Collection 2016

**Figure 11. Crude AMI 30-day mortality rates by STEMI status**

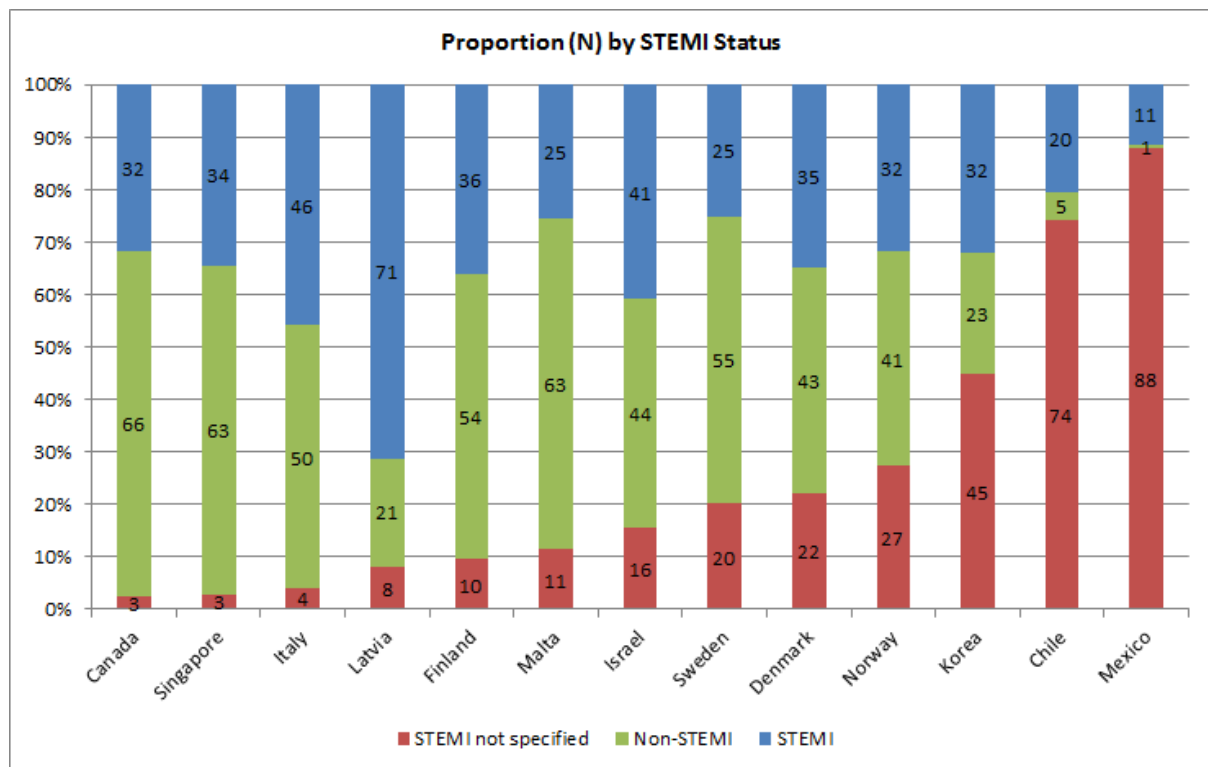


Source: OECD Pilot Hospital Performance Data Collection 2016

136. The proportion of denominator cases by STEMI status reported by participating countries is presented at Figure 12. Marked differences in the proportion of STEMI not specified cases are noted, ranging from less than 5% in Canada to nearly 90% in Mexico. Similar disparities exist for STEMI and non-STEMI cases, with 71% cases reported as non-STEMI in Latvia compared with only 11% of cases in Mexico.

137. Consideration of these data outcomes by the methodology experts led to the conclusion that STEMI status was not a reliable risk variable and that the implausible variations in STEMI status rates and proportions are more likely to reflect differences in coding practices and quality than real differences in STEMI status.

Figure 12. Proportion of AMI denominator cases by STEMI status



Source: OECD Pilot Hospital Performance Data Collection 2016

138. The OECD has consequently excluded STEMI status from the risk standardisation of AMI 30-day mortality rates, even though there is broad recognition that STEMI status is an important mortality risk factor. This decision highlights, once again, the practical challenges that exist in developing robust international comparisons of hospital performance and the methodological choices that need to be made given the current state of development and existing variations in quality of the health information infrastructure across OECD countries.

### ***Practical decisions made***

139. Following two years of methodological development including pilot data collections and ongoing advice from a group of methodological experts, the OECD has adopted the following risk variables for the risk standardisation of the unlinked data-based and linked data-based calculations of the AMI 30-day mortality indicator:

#### *Unlinked data-based (including transfers)*

- Age and sex
- Comorbidity (Charlson Index) as identified in the secondary diagnosis codes of the reference admission

#### *Linked data-based calculation (last hospital episode)*

- Age and sex

- Comorbidity (Charlson Index) as identified in the secondary diagnosis codes of the reference admission and any diagnosis codes of any admission of the same patient within the previous 365 days.
- Previous AMI as identified in any diagnosis codes of any admission of the same patient within the previous 365 days.

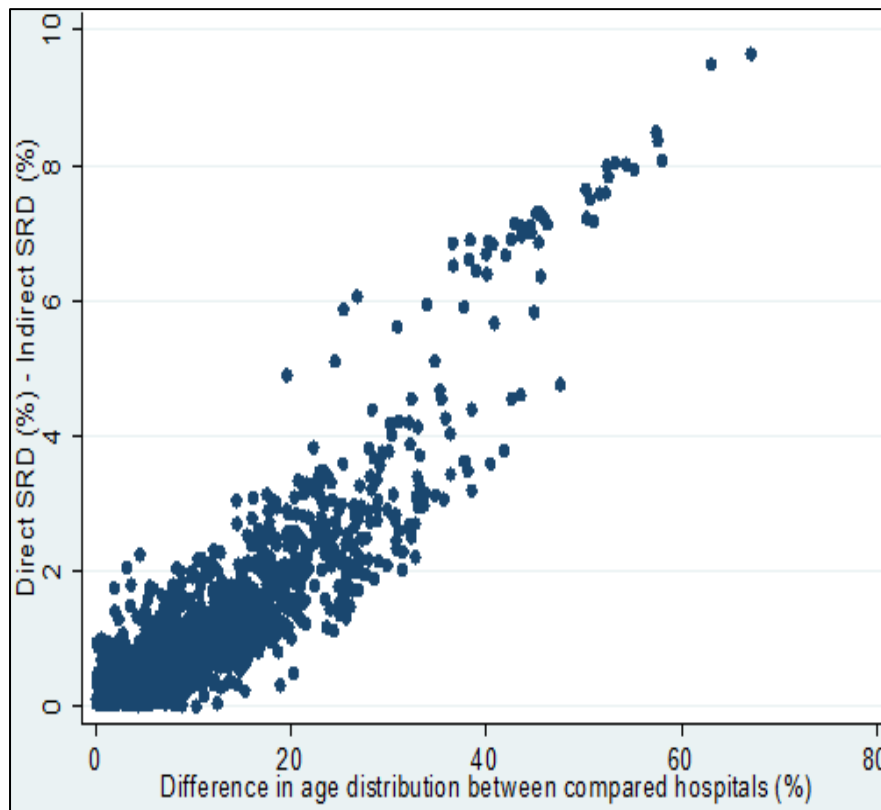
## 2.6. What standardisation approach did we use?

140. There are numerous techniques for standardizing hospital or national-level mortality rates. Indirect standardization compares hospital mortality to expected mortality calculated from a reference population. Direct standardization uses hospital level mortality rates and weights these rates by the standard reference population structure. Differences exist in the utility of each standardization technique for comparing hospitals across countries. Specifically, direct standardization is more appropriate for comparing hospitals to each other than indirect standardization. However, direct standardization is prone to highly variable rates among hospitals with lower numbers of cases whereas this is less a problem in indirect standardization. Given indirect standardization compares hospital mortality to expected mortality, direct comparisons of hospitals to each other are not technically possible which may be preferable under certain conditions.

141. As identified earlier in this paper, the chosen method for risk standardisation for the OECD pilot data collection in 2016 was indirect standardisation. However, during the deliberations of the methodology experts and the broader Health Care Quality Indicator Expert Group it became apparent that some countries and researchers were starting to develop and give preference to the use of alternative methods of standardisation, including approaches to direct standardisation and various hybrid models.

142. For example, Italy has conducted work that demonstrates marked differences between direct and indirect standardisation of AMI 30-day mortality rates occur where significant imbalances exist in the age distribution between hospitals in Italy (see Figure 13).

**Figure 13. AMI 30-day mortality: difference between direct and indirect standardization as a function of imbalance in age distribution between hospitals, Italy**



*Note:* Direct SRD: mortality rate using direct standardization. Indirect SRD: mortality rates using indirect standardization.

*Source:* Source: Unpublished data presented at OECD methodology expert meeting, September 2017

143. Sweden, along with partners from the University of Ghent, has also been working on the development of methods of direct standardization including those based on logistic regressions. This technique is intended to respond to issues with direct standardisation methods caused by hospitals with a small number of AMI admissions. Casemix standardised rates of AMI 28-day mortality rates have recently been presented for hospitals in Sweden based on this method of direct standardisation.

144. More recently researchers from the Gertner Institute for Epidemiology and Health Policy Research in Israel completed an in depth analysis of a number of standardization methods, including indirect, direct and hybrid models (Freedman, 2017). This analysis explored the use and utility of these techniques in measuring AMI 30-day mortality rates and has been tested using Israeli hospital data.

145. The analysis compared five different methods of standardization including models being explored in other countries (e.g. Italy, Sweden):

- Conventional direct standardization
- Conventional indirect standardization
- Hybrid model 1- the model selects the direct or indirect standardization based on lowest mean squared error

- Hybrid model 2- a weighted average of direct and indirect standardized rates taking into account the mean squared error of each estimate
- Logistic regression method

146. Results showed wide variations in AMI rates among standardization techniques when adjusting for age, sex, and co-morbidity. This may be due to large differences in co-morbidity distribution between hospitals and the reference population. Differences between techniques were greatly reduced when standardizing by age and sex only. This was perhaps because differences between hospitals and reference populations were reduced with restricted adjustment variables.

147. The methodology experts noted that the different standardization methods created quite different risk standardized rates and were interested in exploring the generalisability of the findings for hospitals in Israel by extending the analysis to hospital data from other OECD countries. The experts were particularly interested in exploring the feasibility and robustness of these early results in countries with different comorbidity profiles and a greater range of hospital size. It was noted that the OECD pilot data collections included a significant proportion of hospitals with a low throughput of AMI cases, which may generate additional methodological issues for applying direct standardisation methods.

148. Given the growing interest by some experts in exploring further both direct and indirect methods of risk standardisation and the indications that hospital-level AMI 30-day mortality rates can be sensitive to the choice of method, the OECD included specifications for direct standardisation (in addition to indirect standardisation) in a pilot data collection on AMI 30-day mortality rates in 2017.

149. To determine the effect of the standardization methods on mortality rates, an analysis of the impact of the direct and indirect methods on generating positive and negative outlier rates in relation to the 99.7% control limits of the reference population crude rate was undertaken (see Table 10).

**Table 10. Positive and negative outliers by standardization technique for admission and linked data-based calculations including all countries**

	Total Hospitals	Positive outliers		Negative outliers	
		N	%	N	%
Unlinked data-based					
Indirect standardization	1615	164	10.2	108	6.7
Direct standardization	1615	213	13.2	84	5.2
Linked data-based					
Indirect standardization	1210	134	11.1	37	3.1
Direct standardization	1210	115	9.5	57	4.7

*Note:* only hospitals with over 50 AMI admissions included in analysis. Positive outlier are hospitals with mortality above expected values. Negative outliers are hospitals with mortality below expected values.

*Source:* OECD Pilot Hospital Performance Data Collection 2017

150. The impact on outlier rates was moderate. For unlinked data-based calculations, direct standardization increased the number of positive outliers and decreased the number of negative outliers. These effects were reversed for the linked data-based calculations.

151. At the hospital level the impact of direct and indirect standardisation on rankings for Israel were considered (see Table 11).

**Table 11. Change in Israel hospital ranking by standardization method using unlinked data-based calculation**

Indirect standardization	Direct standardization
13	38
38	13
14	14
34	23
30	30
11	26
23	11
18	34
2	18
12	35
26	24
24	12
16	2
7	7
35	16
9	15
15	9
3	3
36	27
27	21
5	36
20	5
21	20
32	32
22	22
28	28

Source: OECD Pilot Hospital Performance Data Collection 2017

152. The comparison of the ranking of risk standardised unlinked data-based AMI 30-day mortality rates resulted in large changes in hospital rankings within Israel being observed, with hospitals changing as many as 5 ranks. This indicates that choice of standardization method can have a strong effect at the hospital level.

### ***Practical decisions made***

153. Irrespective of technical issues with alternative methods of risk standardisation, the OECD recognises that the choice of standardisation method largely depends on the principal objective of the measurement programme and this may vary across OECD countries currently participating in national AMI 30-day mortality data collections. In some countries the ability to compare performance of hospitals with each other (direct standardisation) may be more important than comparing the performance of a hospital with

the average across all hospitals (indirect standardisation). While in other countries, there may be policy considerations that promote the avoidance of direct hospital comparisons and rankings.

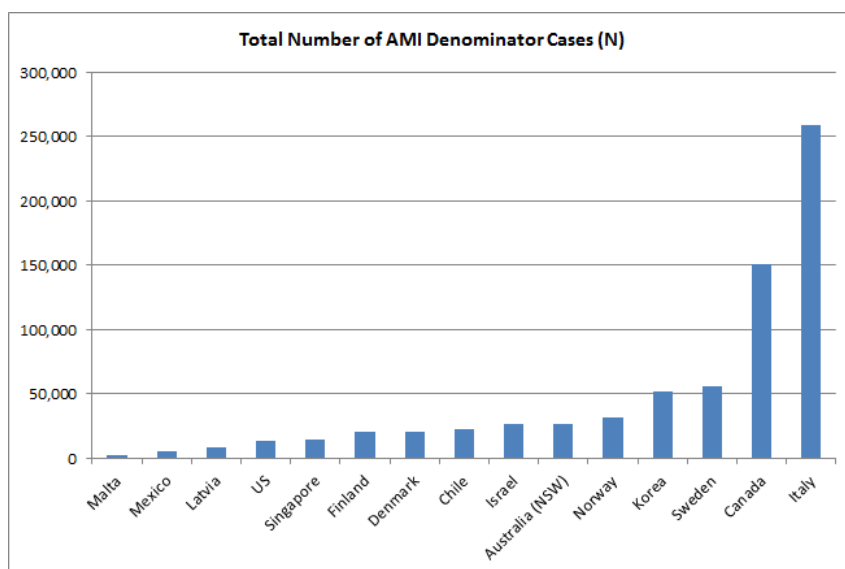
154. Further research and development is underway to assess the feasibility and robustness of alternative approaches to risk standardisation of the AMI 30-day mortality indicators developed by the OECD, including direct and indirect methods. While the focus of data publication to date has been on indirect standardised indicator rates, the OECD plans to continue to collect data to enable the calculation of AMI 30-day mortality rates using multiple methods of risk standardisation to allow more flexible presentation and publication of data in the future.

## 2.7. How was the reference population created?

155. A fundamental aspect of a risk standardisation methodology is the construction of a reference population. Ideally the risk profile of the reference population is not markedly different from that of the individual countries and hospitals included in the pooled data or compared with the reference population.

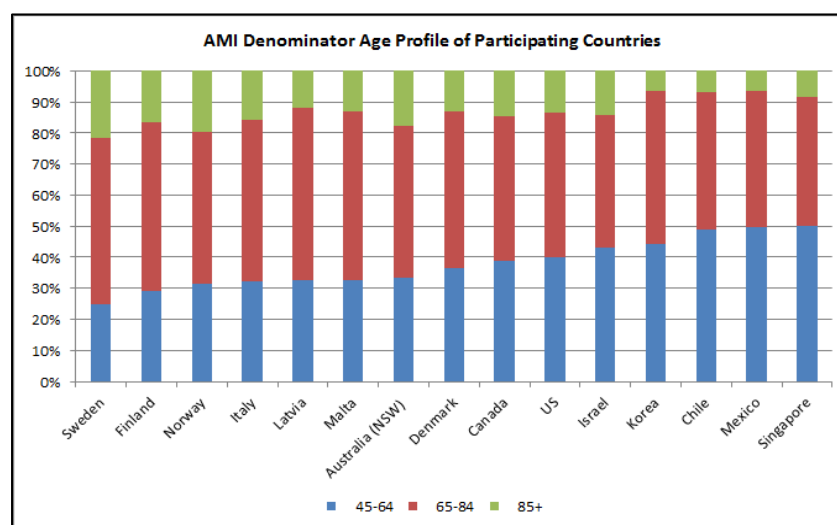
156. As identified earlier in this paper, the reference population for the OECD pilot data collection on AMI 30-day mortality rates in 2016 was created in such a way that the pooled hospital data from each participating country had an equal influence on the reference population. Upon reflection of the outcomes of the 2016 data collection, the methodology experts noted that the reference population was developed from a heterogeneous set of countries with significantly different size indicator populations (see Figure 14) and age profile (see Figure 15), STEMI status proportions and observed AMI case fatality rates.

**Figure 14. Total number of AMI cases included in the denominator by country**



Source: OECD Pilot Hospital Performance Data Collection 2016



**Figure 15. Age profile of AMI cases included in the denominator by country**

Source: OECD Pilot Hospital Performance Data Collection 2016

157. The methodology experts consequently agreed that sensitivity testing of the reference population would be worthwhile to assess the relative impact of variations in the composition and structure of the reference population on AMI 30-day mortality rates for countries and hospitals, including the weighting (or not) of smaller countries and the exclusion (or not) of outliers.

158. The following three constructions of the reference population were utilised in the OECD pilot data collection in 2017:

- Reference Population 1 included data from all eligible countries without any weighting.
- Reference Population 2 included data from all eligible countries and countries were weighted so that each country had a weight of one in modelling and calculation of the crude mortality rate.
- Reference Population 3 excluded “outlier” countries which had mortality rates significantly higher than the average and weighted calculations so each country had a weight of one in modelling and calculation of the crude mortality rate.

159. The crude mortality rate subsequently calculated for each reference population is presented in Table 12. The largest difference in crude rates between the three reference population constructions was observed in the case of the weighted reference population including all countries (Reference Population 2). This was because some small countries had relatively high mortality rates and their influence upon the reference population was increased by weighting.

**Table 12. Crude mortality rates for three reference population constructions**

Reference population	Unlinked data-based			Linked data-based		
	1	2	3	1	2	3
Crude mortality rate	6.11	7.21	6.16	8.87	10.48	9.03

Source: OECD Pilot Hospital Performance Data Collection 2017

160. Weighting countries exaggerates the influence of small countries and changes the reference population mortality rate when rates for small countries are significantly different from the mean rates.

161. The impact of each reference population was also assessed using hospital-level data, where the principal interest was in exploring which hospitals lie outside the 99.7% control limits of the reference population crude rate when making comparisons across or within countries. The effect of different reference population constructions may therefore be measured by the number and location of these “outlier” hospitals.

162. Table 13 summarises the impact of each reference population construction on the number and proportion of outlier hospitals. A positive outlier is when the AMI 30-day mortality rate of the hospital is higher than expected and conversely a negative outlier is when the rates of a hospital are lower than expected.

**Table 13. Positive and negative outliers by reference population construction (unlinked data-based)**

	Total Hospitals	Positive outliers		Negative outliers	
		N	%	N	%
Reference population 1	1615	164	10	108	7
Reference population 2	1615	76	5	287	18
Reference population 3	1615	146	9	129	8

*Note:* only hospitals with over 50 AMI admissions included in analysis. Positive outlier are hospitals with mortality above expected values. Negative outliers are hospitals with mortality below expected values.

*Source:* OECD Pilot Hospital Performance Data Collection 2017

163. The differences between the outliers among model 1 and model 3 are relatively small. The outliers for the linked data-based calculation also followed the same pattern as the unlinked data-based. The weighted reference population including all countries (Reference Population 2) decreased positive outliers and increased negative outliers relative to other reference populations. This was largely due to the upward impact of small countries with higher crude mortality rates on the reference population rate.

164. At the hospital level the impact of different reference population constructions on rankings for Israel were considered (see Table 14).

**Table 14. Israel hospital ranking by reference population for admission- based calculations**

Rank among Israeli hospitals - Patient based			
Reference pop 1	Reference pop 2	Reference pop 3	
2	2	2	
23	23	23	
14	14	14	
34	26	18	↘ ↗
18	18	34	↘ ↗
11	13	11	↘ ↗
26	34	26	↘ ↗
13	11	13	↘ ↗
16	16	30	↘ ↗
30	24	16	↘ ↗
24	30	24	↘ ↗
7	7	7	
9	9	9	
36	27	36	↘ ↗
15	15	27	↘ ↗
27	36	15	↘ ↗
38	38	38	
21	12	35	↘ ↗
35	3	21	↘ ↗
12	35	12	↘ ↗
3	21	3	↘ ↗
20	20	20	
5	5	5	
22	22	22	
32	32	32	
28	28	28	

Source: OECD Pilot Hospital Performance Data Collection 2017

165. Moderate changes to hospital rankings were observed across the three reference population constructions, with some hospitals moving plus or minus three ranks. The methodology experts considered this could be expected as hospital populations can be quite heterogeneous and sensitive to changes in model coefficients.

### ***Practical decisions made***

166. The existing convention for creating and presenting OECD averages and for risk standardisation of existing health indicators is based on the principle that each country has equal weight and influence in the calculations. The methodology experts identified that while this may be justified when the principal unit of measurement is at the national level, but may need to be revised when considering performance at the hospital level.

167. The consideration of different constructions of the reference population during the development of the hospital level AMI 30-day mortality indicator data collection highlighted the potentially distorting effects of giving equal weight to outlier mortality rates in smaller countries in the calculation of risk standardised rates. Further, that data quality and availability is an important factor to take into consideration when deciding which of the participating countries to include in the reference population. For example, a number of

countries providing data during the OECD pilot data collections were not able to provide nationally representative data or the secondary diagnosis coding necessary for calculation of a co-morbidity score.

168. The OECD has adopted the use of an unweighted approach to the construction of the reference population for the hospital-level AMI 30-day mortality indicator data collection. Data from all participating countries that are deemed to be of sufficient quality (e.g. nationally representative, compliance with specifications, sufficient coding quality) will be included in the construction of the reference population from each data collection.

## 2.8. How did we manage mortality rates in small hospitals?

169. Small caseloads and low incidence of AMI 30-day mortality can together reduce the ability to distinguish true differences in the performance of hospitals. The challenge of dealing with the potentially high variability of mortality rates for smaller hospitals from countries participating in the OECD pilot data collections was recognised early in the development of the hospital-level data collection on AMI 30-day mortality rates.

170. A key methodological decision taken early in the development of the indicator specifications was to consolidate data over three consecutive calendar years in calculating AMI 30-day mortality rates. This decision was taken to maximise the possibility of achieving threshold caseloads across participating hospitals whilst maintaining the feasibility and usefulness of indicator data for decision-making within health systems.

171. While the methodology experts generally agreed that data reliability is limited for hospitals with smaller AMI caseloads, there was equal agreement that consideration of the quality of care in these hospitals is important and requires consideration in the assessment of hospital performance within a country and internationally. Discussion over two main related issues was taken up by the experts during the course of the development of the OECD pilot data collections on AMI 30-day mortality rates:

1. What is considered to be an appropriate minimum AMI caseload to adequately assure the reliability of hospital AMI 30-day mortality rates?
2. How could the AMI 30-day mortality rates of hospitals with caseload less than the threshold be appropriately integrated into the overall performance assessment?

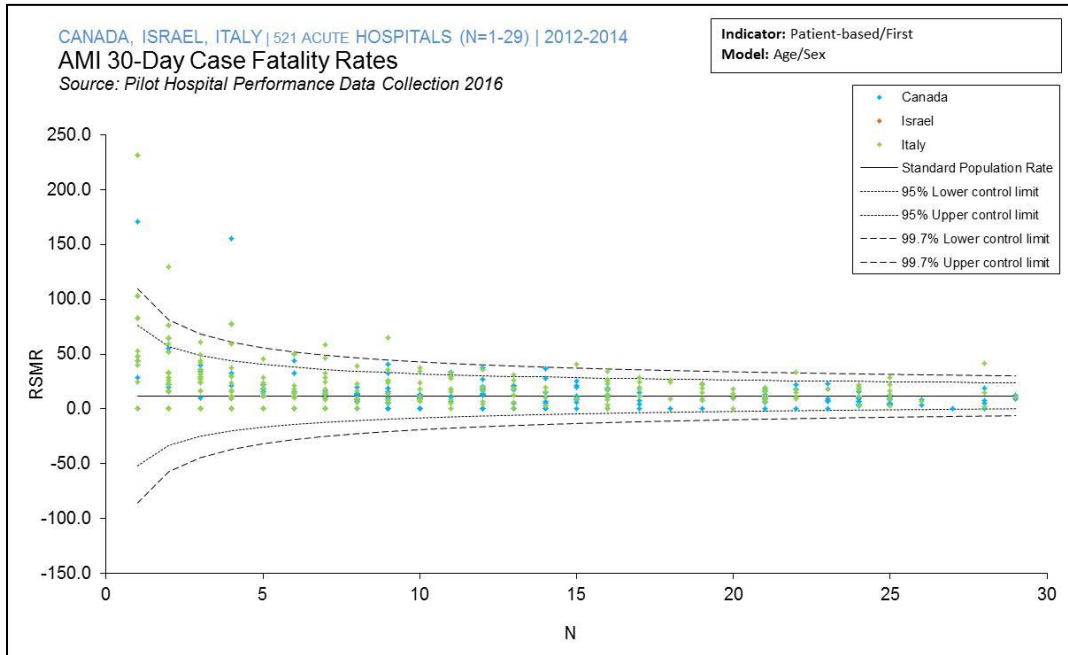
### ***Determining minimum hospital caseload***

172. The incidence of mortality within 30 days of admission for an AMI varies significantly across the countries reporting to the OECD, with unlinked data-based calculation rates of less than 4 per 100 admissions in Norway, Denmark and Australia as compared with rates more than 13 per admissions in Latvia, Hungary and Mexico published in *Health at a Glance 2017* (see Figure 1). This data confirms that on the basis of national AMI caseloads there is the need to have on average at least 25 AMI cases in order to expect the incidence of a mortality case in all countries.

173. During initial exploratory work undertaken by the OECD at the hospital level, the Health Care Quality Indicator experts supported the application of minimum hospital caseload of 30 cases (i.e. denominator count) within the reference period. The OECD pilot hospital performance data collection in 2016 confirmed wide variability in rates and the existence of a relatively higher incidence of zero values across hospitals with smaller caseloads (see Figure 16).

174. Further consideration of the variations in AMI 30-day mortality rates across the distribution of hospital caseloads was undertaken to inform future determination of the minimum hospital caseload. In addition to the impact on the proportion of hospitals with zero rates, attention was given to the impact of applying different minimum caseload levels on the average crude rates and remaining proportion of total hospitals.

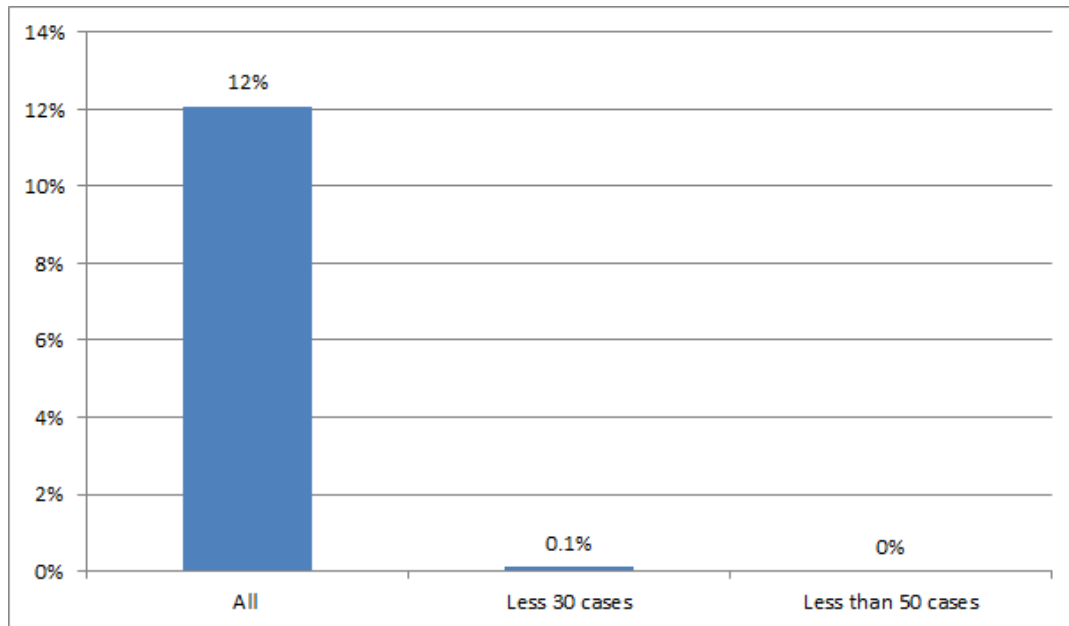
**Figure 16. Funnel plot of age and sex risk standardised AMI 30-day mortality rates for hospitals with caseloads less than 30 cases during 2012-2014 in Canada, Israel and Italy**



Source: OECD Pilot Hospital Performance Data Collection 2017

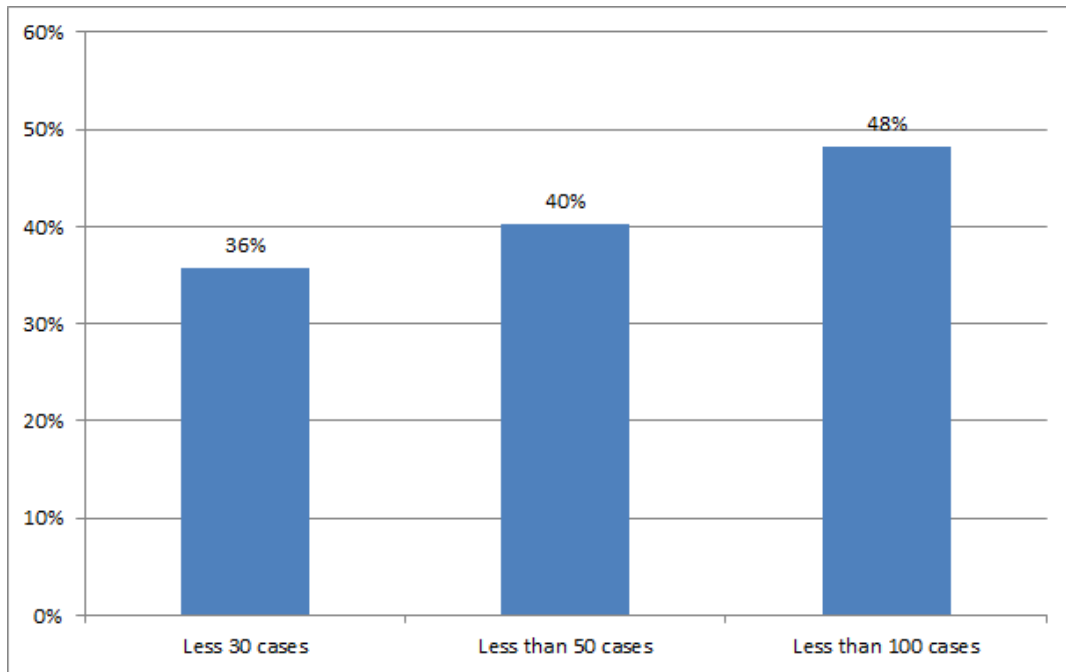
175. Figure 17 demonstrates that the proportion of hospitals reporting AMI 30-day mortality rates of zero decreases as the caseload level of hospitals increase. This gives some broad empirical indication of what caseload may be required to reflect reliable hospital level AMI 30-day mortality rates.

**Figure 17. Proportion of hospitals with AMI 30-day mortality rates of zero by AMI caseload 2013-2015.**



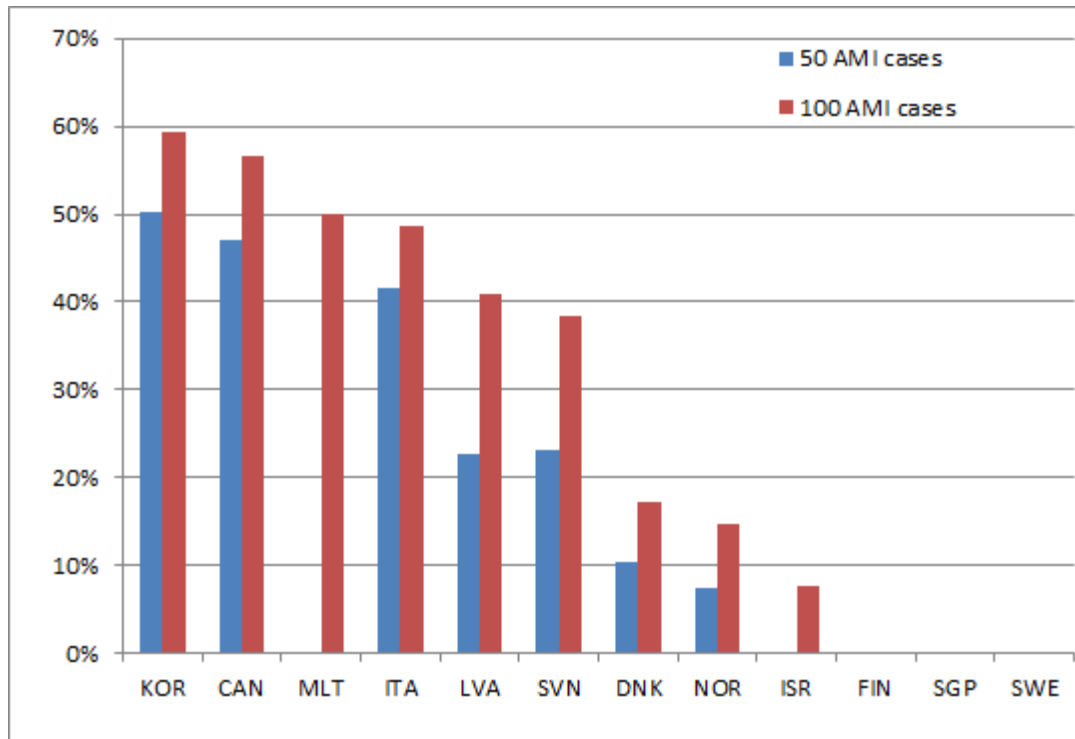
Source: OECD Pilot Hospital Performance Data Collection 2017

176. While the selection of a minimum hospital caseload has implications for the reliability of the data, it also has a differential impact on the level and dispersion AMI 30-day mortality rates and the proportion of total hospitals that remain in the data for each country and the pooled data. Predictably, by increasing the minimum caseload from 30 to 50 and then to 100 cases, the proportion of hospitals that are excluded from the pooled data increases (see Figure 18). However, while 40% of hospitals are excluded with a minimum caseload of 50 cases, the proportion of hospitals excluded only increases a further 8 percentage points when the minimum caseload is doubled to 100 cases.

**Figure 18. Proportion of hospitals below minimum AMI Caseloads, 2013-2015**

Source: OECD Pilot Hospital Performance Data Collection 2017

177. Figure 19 shows that at a minimum caseload at 50 cases, over 40% of hospitals in Korea, Canada and Italy are excluded whereas in Israel, Finland, Singapore and Sweden no hospitals are excluded.

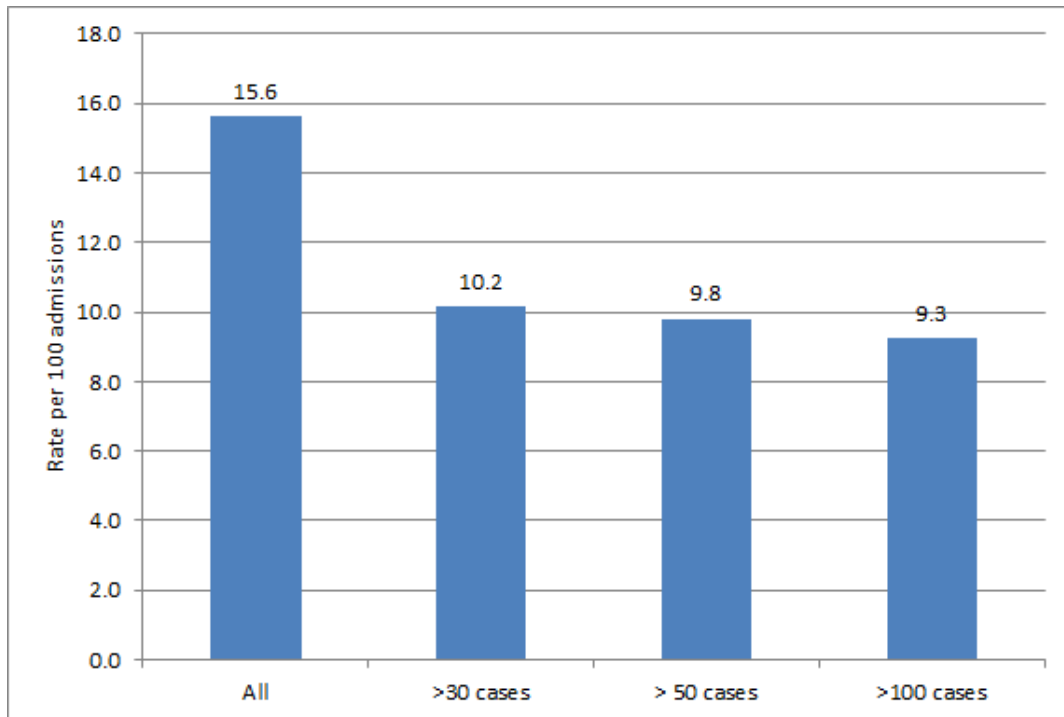
**Figure 19. Proportion of hospitals below minimum AMI Caseloads by country, 2013-2015**

Source: OECD Pilot Hospital Performance Data Collection 2017

178. By increasing the minimum caseload from 50 to 100 cases, the proportion of hospitals that are excluded increases for most countries. However, the impact is disproportionate across countries with less impact in Italy and Canada relative to other countries. While this may appropriately reflect the structure of the hospital system in each country, the exclusion of hospitals at different threshold levels has implications for national and international interpretation. For example, the impact on crude AMI 30-day mortality rates of applying different minimum caseload levels to the pooled data is illustrated at Figure 20.



**Figure 20. Crude AMI 30-day mortality rates for hospitals below minimum AMI caseloads, 2013-2015**



Source: OECD Pilot Hospital Performance Data Collection 2017

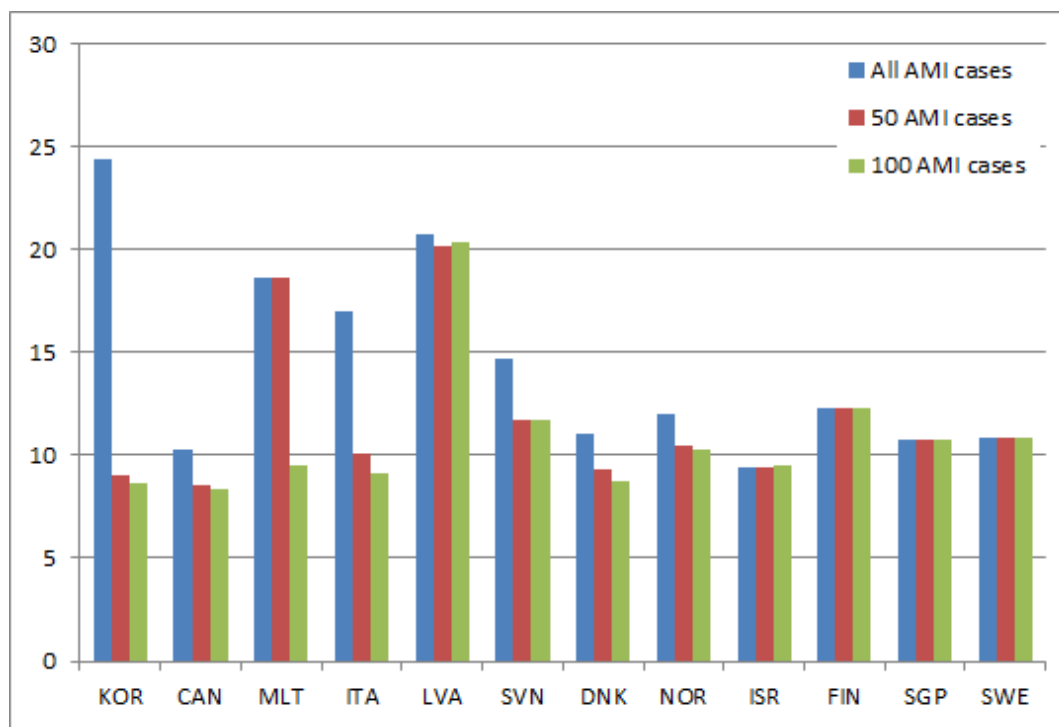
179. Although only marginal changes in the crude rate is observed at minimum caseloads above 50 cases, the impact varies across countries (see Figure 21) with large reductions in crude rates observed in Korea and Italy where a larger proportion of hospitals with less than 50 AMI cases were reported and no change in rates for Finland, Singapore and Sweden where no hospitals with caseloads less than 50 were reported.

180. However the level of impact was not proportional across countries. For example, the impact for Canada was more modest, even though over 40% of hospitals were excluded by applying the 50 case threshold. It is noted the impact of raising the minimum caseload from 50 cases to 100 cases is modest for all countries, except for Malta. This impact is due to the fact that only two hospitals were reported for Malta.

181. In light of these data outcomes and the conventional wisdom of the methodology experts, it was agreed the minimum hospital caseload would be increased to 50 cases over the three year reference period for the OECD hospital level data collections on AMI 30-day mortality in the future. While some national and international initiatives have excluded hospitals using a higher minimum caseload (for example, 100 cases), 50 cases was consider appropriate given the distribution of indicator values across various caseload levels and the overall aim to maximise the appropriate retention of hospitals in the analysis dataset.

182. This threshold was applied during a preliminary analysis of the OECD pilot hospital performance data collection in 2017 to consider the relationship between hospital characteristics (including caseload, location, teaching status, speciality services, and ownership) and AMI 30-day mortality rates.

**Figure 21. Crude AMI 30-day mortality rates for hospitals below minimum AMI caseloads by country, 2013-2015**



Source: OECD Pilot Hospital Performance Data Collection 2017

183. The study found some evidence of a volume effect across the 12 participating countries, with a high volume of AMI admission associated with a lower risk standardized rate in a model using a restricted number of hospital characteristics ( $-0.83$ ,  $p < 0.001$ ). However, interestingly, while the rate across all 12 countries was 9.06, the rates of hospitals with fewer than 50 AMI admissions (which were excluded from the analysis) ranged from 0 to 447.11, with an average of 17.29 and a standard deviation of 36.73.

### ***Hospitals with small caseloads***

184. The Health Care Quality Indicator experts and the group of methodology experts broadly agreed that hospitals with small AMI caseloads should be excluded from national and international comparisons of AMI 30-day mortality rates, given concerns over the low reliability of the rates for these hospitals. The OECD has set the minimum AMI caseload at 50 cases and hospitals with over 50 AMI admissions during the three year reference period have been included in international comparative analysis and reporting to this point.

185. Data from hospitals with caseloads less than 50 cases will continue to be sought through the OECD hospital-level data collection of AMI 30-day mortality rates and included in national level descriptive tables and figures, with further exploration of methodological options required to identify appropriate approaches to hospital performance comparison for this stratum of hospitals. Expert advice provided to date suggest a number of possible approaches including:

- Consolidation of cases across hospitals with a caseload less than 50 cases in a country to create one entity with sufficient data reliability for inclusion in national and international comparisons.

- Report the number of mortality cases rather than the mortality rates for hospitals with a caseload less than 50 cases and by implication treat each case as justifying follow up within a country similar to sentinel safety events.

## 2.9. How did we deal with issues of data exchange?

186. A key methodological challenge faced by the OECD in seeking to establish an international hospital level data collection on AMI 30-day mortality rates across 35 member countries related to the capacity for countries to readily share the data required to adequately risk standardise the rates for international comparison.

187. In order to identify and specify the approach to indicator specification and risk standardisation of hospital outcome indicators, such as AMI 30-day mortality rates, research agencies generally rely on direct access to patient level data. For example, both the international ECHO and EuroHOPE projects relied on access to patient level data from countries in developing and successfully implementing their respective approaches to international indicator work.

188. The exchange of health data between agencies and countries is generally highly regulated to protect patient privacy and ensure confidentiality. The exchange of health care data that provides the potential to identify an individual person or, in some cases, an individual entity is carefully controlled and restricted to defined and agreed sets of circumstances considered in the public interest. While data of this nature is regularly provided for specific research and development purposes, the submission, ethical consideration and approval process can be complex and time consuming. For example, it is understood that the agreements for data exchange for recent European projects extended over multiple years.

189. The 36 OECD member countries participating in the Health Care Quality Indicator experts group confirmed early in the development of the OECD hospital level AMI 30-day mortality indicator data collection that the exchange of patient level data from a sufficient number of countries would not be feasible. Further, that data under a certain nationally regulated cell size (ranging from a cell size of 5 in most European countries to over 10 in the United States) would also need to be suppressed in any aggregated data provided to the OECD for the purposes of this initiative.

190. This is an example of a broader issue, which the OECD is now confronting (OECD, 2015). The organisation has been working with member countries over recent years to establish and grow opportunities to use health data for improving health care quality, surveillance, health system management and research. But to leverage this potential while managing risks that might come from the misuse of data that are personal, appropriate governance frameworks are needed.

191. In January 2017 a Recommendation of the OECD Council on Health Data was passed that lays out the framework conditions to encourage greater availability and processing of health data within countries and across borders for health-related public policy objectives. Progress in developing the conditions for health data sharing will be monitored over the longer term, but for now significant challenges remain in progressing robust international health care performance comparisons.

### *Avoiding direct access to patient level data*

192. The group of international methodology experts considered various approaches to overcoming the limitations on direct access to patient data from all participating countries.

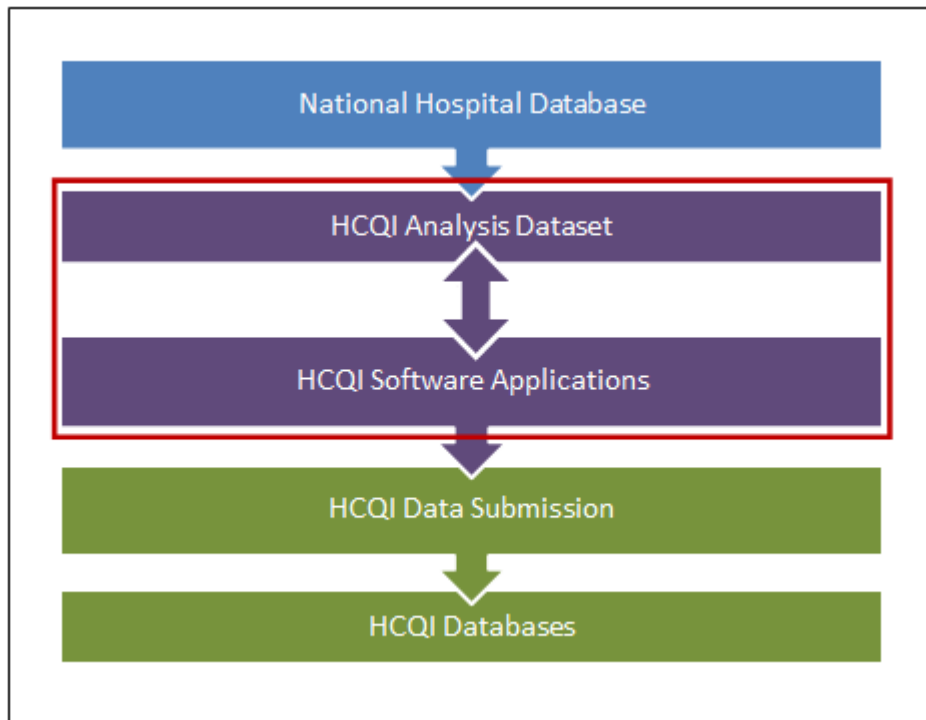
- One approach identified would involve the regression coefficients required for risk standardisation being generated from pooled data from a limited number of countries with the capacity to exchange patient data. The coefficients would then be applied to all participating countries to generate standardised rates. This approach had previously been applied by the EuroHOPE project.
- An alternative approach identified would involve the pooling of micro aggregations of patient data from all participating countries. This data would be sufficiently aggregated to protect patient privacy and allow countries to exchange data within their current cell size limitations. But also be granular enough to provide sufficient specificity on key risk variables to generate regression coefficients and enable meaningful risk standardisation. The European diabetes project EUBIROD successfully utilised this method in their international measurement efforts.

193. The central assertion of this method is that once the key risk variables have been identified and well specified, the requirement to directly access patient data is removed and strata of micro aggregations of patient data can be used to generate identical regression coefficients for risk standardisation of the indicators rates (Carinci 2010).

194. The methodology experts considered the approach based on micro aggregation of data was the preferred approach given it afforded the opportunity to pool data from all participating countries to create a reference population and generate the regression statistics. The pilot data collection methodology for the OECD hospital level AMI 30-day mortality indicator was subsequently based on this method.

### ***Data exchange***

195. In alignment with the general approach to data exchange utilised by the EuroHOPE project and other international initiatives, the OECD developed a distributed data infrastructure model with key components as illustrated at Figure 22.

**Figure 22. Key Components of Distributed Data Infrastructure Model**

196. A fundamental principle of this model was the use of a standardised software application by all participating countries in the calculation of the admission and linked data-based calculations of the AMI 30-day mortality indicator.

197. It was intended that the software developed and provided by the OECD to calculate the indicators would be applied to data from the national routine hospital administrative databases (National Hospital Database) of countries with minimal to no modification.

198. A key issue that needed to be addressed in developing this model is the significant variation that exists in the structure, configuration and definition of data of national routine hospital administrative databases (National Hospital Database) across OECD countries. In order to do this, the OECD specified the structure of a standardised analysis dataset that all participating countries were requested to generate from their national hospital datasets (National Hospital Database), including definition of key variables and data elements (see Table 15).

**Table 15. Illustrative Structure of Analysis Dataset**

Hospital Identifier	Sex	Age	Charlson Score	Previous AMI *	Died ≤30 Days	Count
Hospital 1	Male	[45-65]	[3]	Yes	No	100
Hospital 1	Male	[45-65]	[3]	Yes	Yes	5
Hospital 1	Male	[45-65]	[3]	No	No	70
Hospital 1	Male	[45-65]	[3]	No	Yes	20

Source: OECD Pilot Hospital Performance Data Collection 2017

199. Programs using SAS software were developed by the OECD to support the configuration and reporting of data from participating countries required to create the reference population and generate the regression coefficients and then to calculate and report the hospital level risk standardised rates. This involved careful specification of the risk variables and calculation methods given direct access to patient data was not possible and any significant revision to the specifications would necessarily require additional data collection.

200. The data collection process for the OECD pilot hospital performance data collections were carried in three key steps:

1. Using the OECD supplied SAS program, the participating countries generated and forwarded to the OECD the micro aggregated national data required to create a reference population and generate regression coefficients for the risk variables and the crude mortality rate.
2. OECD pooled the micro aggregated national data received from participating OECD countries, meeting specified data quality criteria, to create the reference population. The regression coefficients for the risk variables were then generated from this data using an ordinary logistic regression model, along with the calculation of the crude mortality rate of the reference population.
3. Using OECD SAS programs, the regression coefficient and crude mortality rate for the reference population were applied to national hospital datasets to calculate and forward to the OECD hospital level risk standardised AMI 30-day mortality rates.

201. Comprehensive indicator specifications and data collection guidelines were prepared by the OECD to support the pilot data collections on the AMI 30-day mortality rates.

202. In applying this data collection model the OECD was able to reduce the data burden on participating countries, assist in the complex calculation of the indicators and ensure a greater level of standardisation across countries. Broader application of this distributed data infrastructure model is now being explored by the OECD for other indicators generated largely from national hospital administrative data.

203. A final methodological consideration faced by the OECD in developing the hospital-level international data collection on AMI 30-day mortality rates was to identify an appropriate way to graphically represent the variation in hospital rates and the dispersion of performance across countries.

## 2.10. How did we graphically represent variations in rates?

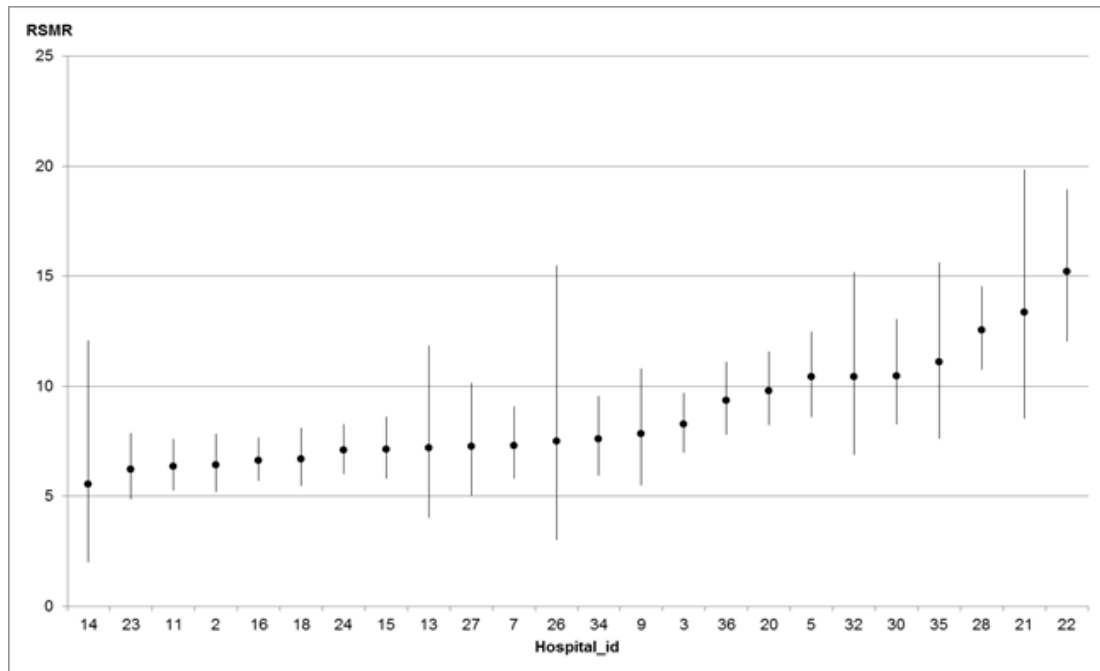
204. The methodological experts providing advice to the OECD stressed the primary importance of a graphical representation that clearly identifies true variations in performance, that is, statistically significant differences in AMI 30-day mortality rates. Other secondary criteria identified for assessing options included:

- Ease of understanding
- A key objective of any graphical representation of data is to facilitate interpretation and clear understanding.
- Capacity to represent many hospitals
- The potential participation of 36 OECD member countries will require a graphical format that does not limit the number of hospitals that can be represented.
- Avoids ranking of hospitals
- Indirect standardisation does not enable direct comparison of one hospital with another and hence the graphical representation should avoid spurious ranking of hospitals.
- Focus on outliers
- While all hospitals may be represented, the focus of the graphical representation should be on those hospitals that are statistically different from the reference population.

205. Four main options for graphically representing the variations in the hospital level rates by participating country were identified and considered by the methodology experts:

- *Forest Plot*  
Presents the risk standardised rate for each hospital in ascending order with representation of the confidence interval to assist in determining statistical different rates (see Figure 23). While clusters of hospitals can be presented on the same plot to enable identification of hospitals in each country, the format may encourage ranking of hospitals and has restrictions in how many hospitals can be practically represented.

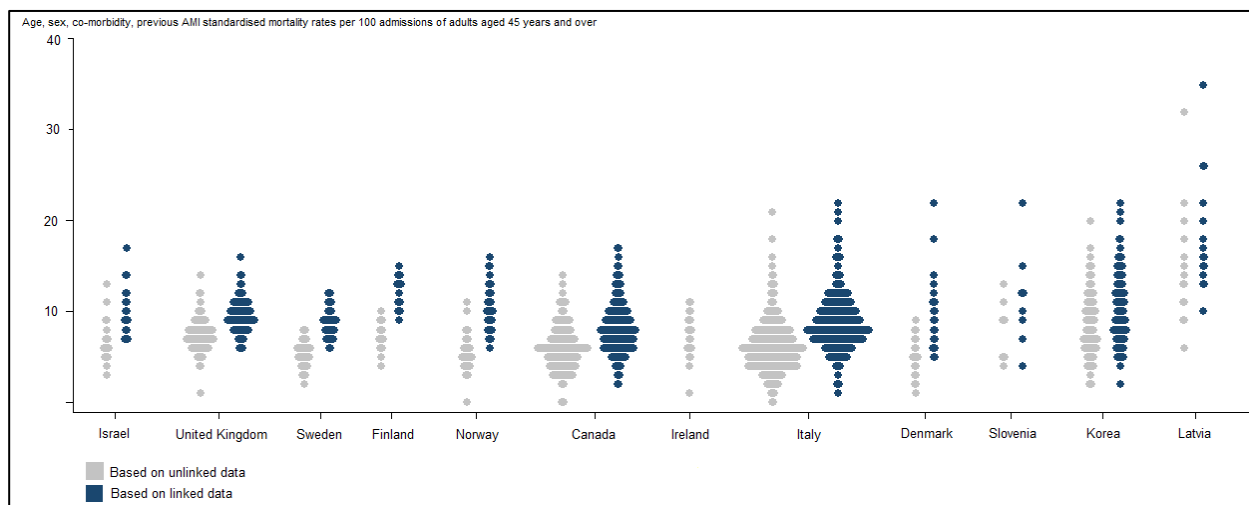
**Figure 23. Illustrative representation of a forest plot of hospital risk standardised mortality rates**



- *Turnip Plot*

Presents the frequency of risk standardised rates of hospitals and thereby graphically summaries the dispersion of performance across hospitals within a country (refer Figure 24). The plots are relatively easy to understand and enable quick comparisons of the level and spread of performance across countries. However, given confidence intervals or limits are not represented, statistically significant differences cannot be identified.

**Figure 24. Illustrative representation of a turnip plot of hospital risk standardised mortality rates**

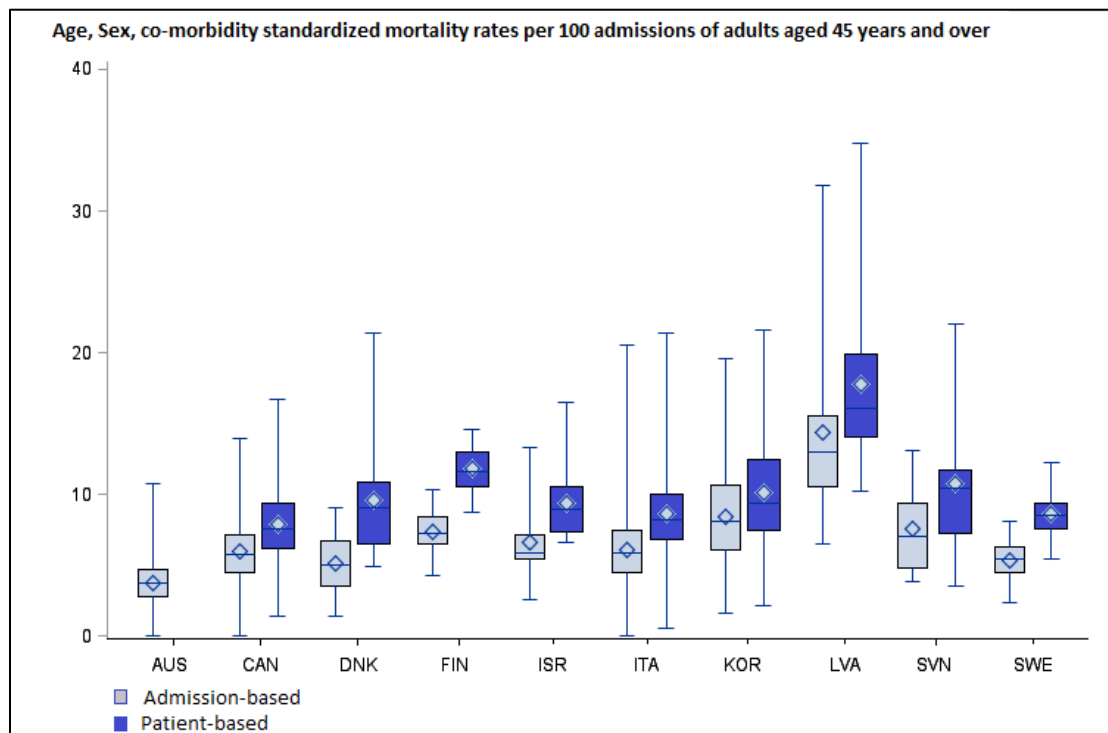




- *Box Plot*

Presents the average, median, interquartile range and the minimum and maximum risk standardised rates of hospitals within a country (refer Figure 25). While these graphs convey a range of helpful information, they require some further knowledge and interpretation to be fully appreciated. They also do not enable statistically significant differences between hospitals to be identified.

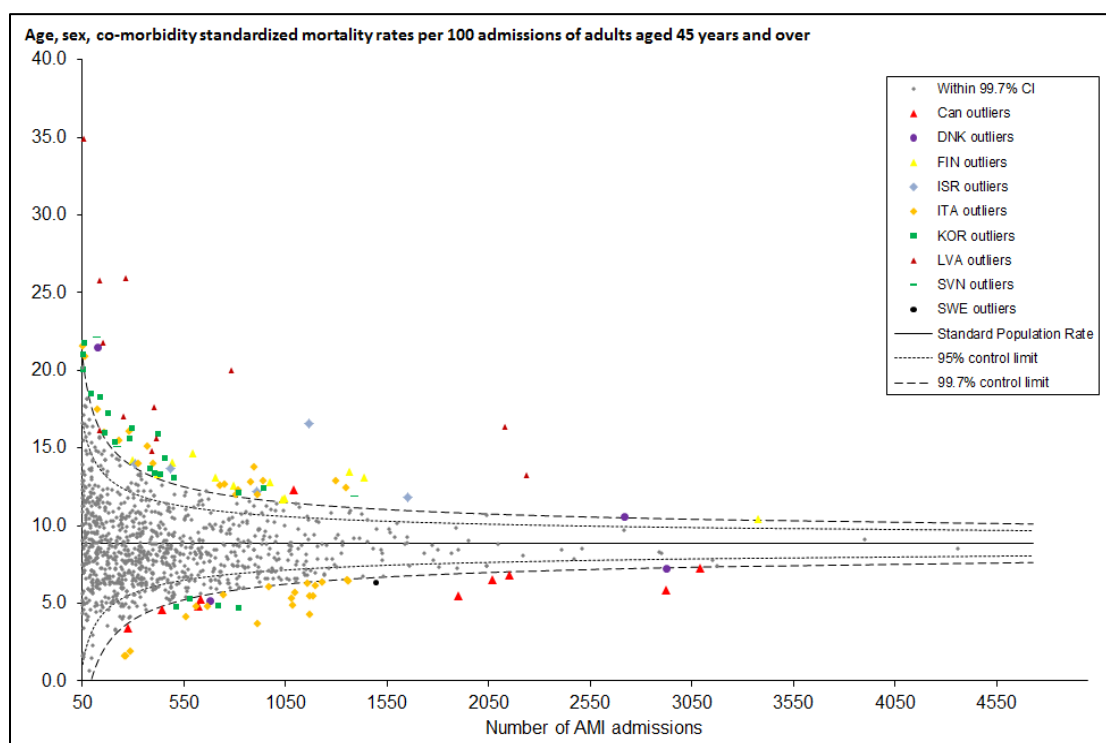
**Figure 25. Illustrative representation of a box plot of hospital risk standardised mortality rates**



- *Funnel Plot*

Presents the risk standardised rate for each hospital according to their AMI caseload, enabling statistical confidence limits to be aligned and narrowed according to ascending size of caseload (see Figure 26). The plots allow outliers to be readily identified and avoid spurious ranking of hospitals. However, they do require some further understanding to fully interpret the results and distinguishing clusters of hospitals by country is challenging.

**Figure 26. Illustrative representation of a funnel plot of hospital risk standardised mortality rates**



206. The OECD published data gathered in 2017 from 12 member countries in Health at a Glance 2017 (OECD, 2017). The methodology experts expressed preference for the presentation of the linked data-based rates, given their relative methodological robustness, and the use of a funnel plot to identify variations in performance of the hospitals from the 12 countries. Given the challenges in appreciating the relative dispersion of hospital performance across countries associated with funnels plots, the OECD decided to also present both the unlinked data-based and the linked data-based rates in the form of a turnip plot. This plot enables the differences in the rates between the two indicators and the variations in the dispersion of performance across countries to be readily appreciated.

207. The OECD recognises the relative merits of each of the identified options for representing the variations in hospital level AMI 30-day mortality rates and the dispersion of performance across countries. As for Health at a Glance 2017, future use of graphical representation will be tailored to the specific priorities for communications and ensure they are fit for purpose.

### 3. PART THREE: CONCLUSION

208. As stated in the introduction, this paper seeks to provide a reference to those looking to understand, and perhaps compare, the specific approach the OECD has taken to measuring AMI 30-day mortality rates and to appreciate the key methodological challenges and practical choices made in order to establish a robust data collection aimed at facilitating meaningful international comparisons and enabling broad participation from across the 36 OECD member countries.

209. The key methodological questions faced by the OECD in developing the international data collection on hospital-level AMI 30-day mortality rates included:

1. How did we approach the fundamental units of measurement?
2. How did we identify the indicator population?
3. How did we identify mortality in the indicator population?
4. How did we attribute performance?
5. How did we account for differences in patient casemix?
6. What standardisation approach did we use?
7. How was the reference population created?
8. How did we manage mortality rates in small hospitals?
9. How did we deal with issues of data exchange?
10. How did we graphically represent variations in rates?

210. In setting out the various methodological choices considered by the experts advising the OECD and the decisions made by the organisation in establishing an international data collection on hospital level AMI 30-day mortality rates, it should be apparent that different analytical methods can result in quite different rates for and rankings of organisations and countries.

211. The specific analytical method adopted by the OECD for the AMI 30-day mortality indicator is one of several valid options considered during the development work of the OECD. This specific methodology differs from that used for national rates of AMI 30-day mortality presented elsewhere in *Health at Glance 2017* and is likely to vary from the methods used by participating countries for national monitoring and reporting purposes, making direct comparison between rates problematic.

212. In reflecting on the experiences of the OECD in developing a hospital level data collection on AMI 30-day mortality rates, the following observations are made regarding the development of hospital level indicators and the implications for ongoing international comparisons:

- Methodological choices require practical decisions

There is a necessary trade off in objectives when developing hospital level indicators in the international context. On the one hand there is the need for more careful specification and risk adjustment to ensure the robustness of the indicators for international comparison. While on the other hand, there are enormous variations in the availability and quality of the data infrastructure across countries which work against the achievement of best practice indicator development. In seeking to enable broad participation of OECD member countries in international comparisons of hospital performance, the pursuit of methodological rigour must at times be tempered.

- Gold Standard Indicator Specifications Require Data Linkage

The OECD has identified and consistently underlined the importance of linking national health data, through the use of a unique patient identifier (UPI), to improve quality and outcome measurement in OECD countries. While there are indications that over 20 OECD countries currently have the capacity to link administrative datasets across hospitals and (in most instances) link these to national death registers, about a third of the countries do not have access to the routine use of a UPI. The methodological considerations and empirical evidence generated through the development of the hospital level AMI 30-day mortality indicator underlines the need for data linkage to achieve the gold standard in calculation of outcomes indicators.

- International comparisons can be made without direct access to patient data

The risk standardisation of hospital level outcomes indicators often requires the pooling of patient data, which is challenging in the international context given the limitations imposed on countries to maintain effective privacy of individuals and ensure data confidentiality. Through the use of micro aggregation of patient data and software code, the OECD was able to apply a method to data collection that generates the similar statistical outcomes as methodological approaches based on direct access to patient data (BridgeHealth, 2017). This approach is now informing the ongoing development of broader indicators data collection processes in the OECD, which may have implications for other international initiatives.

- Further standardisation of international comparisons is required

The OECD actively sought to reflect the state of the art in international hospital outcome indicator specification by identifying and integrating successful methodological approaches developed by existing national and international initiatives. The OECD is indebted to the researchers and agencies that freely shared their knowledge and expertise during the methodological development of the OECD AMI 30-day mortality indicator data collection (see Annex 1). Key objectives for the OECD in carrying out this development work have been to align with best practice and promote harmonisation of methods internationally. For example, the ongoing collaboration with the EuroHOPE and ECHO projects is building basis for further standardisation of international comparisons on hospital performance across Europe (BridgeHealth, 2017).

- More research and sharing of learnings is required to improve international metrics

The OECD considers that the methodological development and pilot data collections undertaken over the two years has resulted in robust and feasible approach to ongoing routine international hospital level data collections on AMI 30-day mortality rates. But as with other indicators in the OECD suite of quality and outcome indicators ongoing methodological development is required to improve international comparisons. Different and equally valid analytical methods can result in quite different indicator rates for and rankings of organisations and countries and therefore it is important that the details of these approaches are made available when reporting and publishing international comparisons of performance. More research and sharing of learnings across countries and research organisations will further improve international metrics.

## 4. ANNEX: DEFINING THE HOSPITAL LEVEL INDICATORS

213. The OECD has adopted two international AMI 30-day mortality indicators for reporting at the hospital-level:

- Calculations based on unlinked data (see “Importance of indicators using linked data”)
- Calculations based on linked data

214. The technical specifications for each of the indicators set out here were used for data collection in 2017. These specifications were generated from a review and refinement of the existing OECD AMI 30-day mortality indicators for reporting at the national level in conjunction with a review of hospital-level indicator constructions and definitions utilised by other international and national initiatives as well as input from a group of international methodological experts.

215. Some key issues in the development of these indicators are covered in more detail in Part Two of this paper.

### 4.1. Acute Myocardial Infarction 30 Day Mortality using unlinked data

#### ***Description:***

216. In-hospital mortality rate within 30 days of being admitted during a specified three-year period for an Acute Myocardial Infarction.

#### ***Coverage:***

- All government and non-government hospitals providing acute non-elective admissions (i.e. urgent/emergency) during the reference period, including private hospitals.
- All hospital admissions (including elective and non-elective acute, sub-acute, non-acute care admissions) from hospitals providing acute non-elective care during the reference period of 1 January 2013 to 1 December 2015.

#### ***Denominator inclusions:***

- All hospital admissions where Urgency Status = Non-Elective (or  $\neq$  Elective) and Care Type = Acute (or equivalent criteria) to ensure only urgent acute care hospital admissions are included.

Note this includes hospital admissions with Discharge Status = Transfer to Hospital for Admitted Care (or equivalent criteria). This variable is used to identify patients discharged from one hospital and then transferred and admitted into another hospital for acute care.

- All hospital admissions where the age at admission is 45 years and over.
- All hospital admissions with a principal diagnosis (PDx) of AMI, represented by one of the following codes:

## ICD-10-WHO

Code	Description
I21.0	Acute transmural myocardial infarction of anterior wall
I21.1	Acute transmural myocardial infarction of inferior wall
I21.2	Acute transmural myocardial infarction of other sites
I21.3	Acute transmural myocardial infarction of unspecified site
I21.4	Acute subendocardial myocardial infarction
I21.9	Acute myocardial infarction, unspecified
I22.0	Subsequent myocardial infarction of anterior wall
I22.1	Subsequent myocardial infarction of inferior wall
I22.8	Subsequent myocardial infarction of other sites
I22.9	Subsequent myocardial infarction of unspecified site

## ICD-9-CM

Code	Description
410.0	Acute myocardial infarction of anterolateral wall
410.1	Acute myocardial infarction of other anterior wall
410.2	Acute myocardial infarction of inferolateral wall
<u>410.3</u>	Acute myocardial infarction of inferoposterior wall
410.4	Acute myocardial infarction of other inferior wall
410.5	Acute myocardial infarction of other lateral wall
410.6	Acute myocardial infarction, true posterior wall infarction
<u>410.7</u>	Acute myocardial infarction, subendocardial infarction
410.8	Acute myocardial infarction of other specified sites
<u>410.9</u>	Acute myocardial infarction, unspecified site

***Denominator exclusions:***

- Same day discharges (where date of admission = date of discharge) where the Discharge Status  $\neq$  Death or Transfer to Hospital for Admitted Care (or equivalent criteria) to ensure only same day discharges where the patient is discharged alive and where the admission did not result in a transfer to another acute inpatient hospital are excluded.

These cases are excluded as they indicate coding issues, given it is unlikely that a course of urgent acute care for an AMI can be completed in one day.

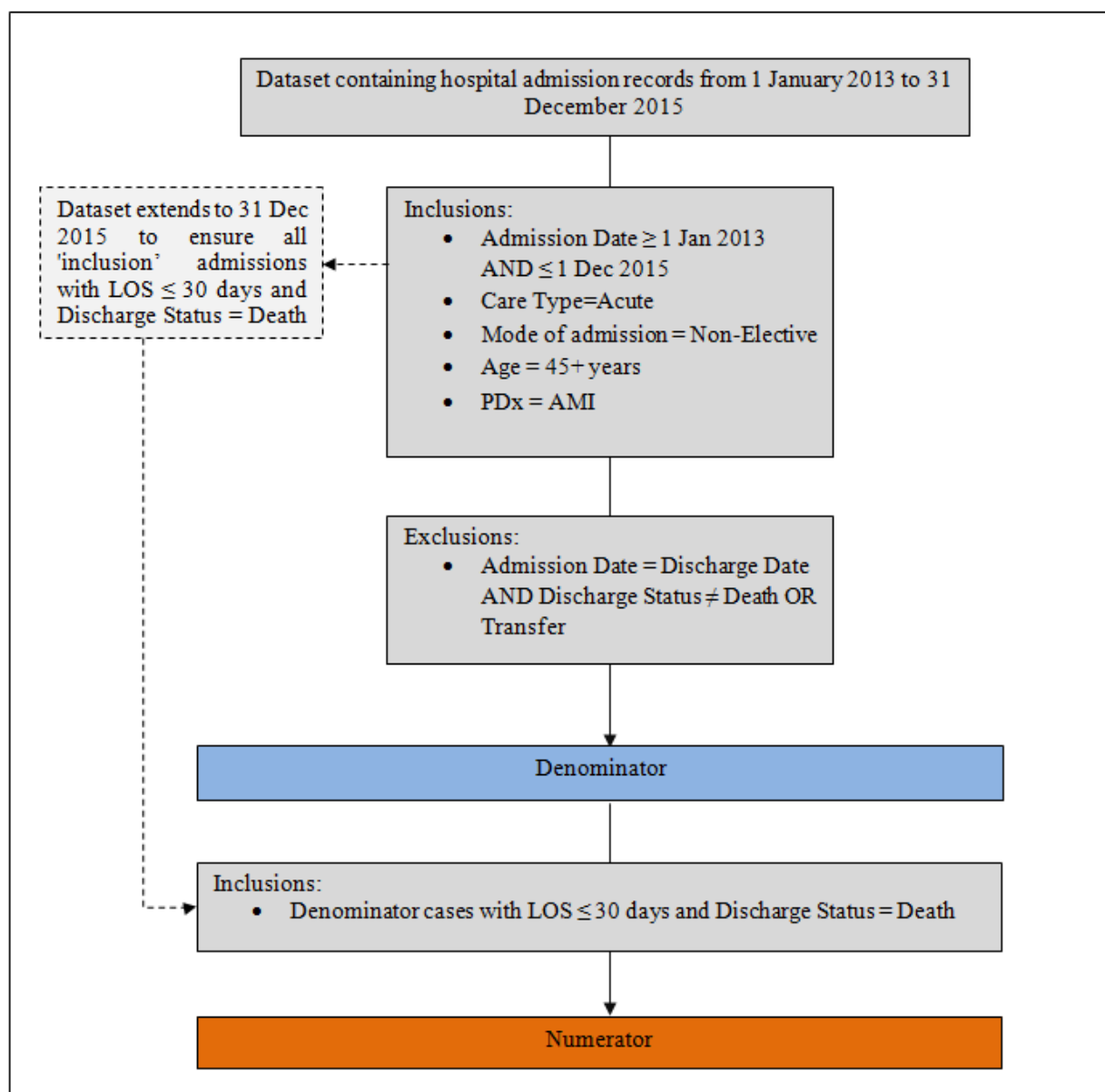
***Numerator inclusions:***

- Numerator cases can only be drawn from the denominator population.
- All denominator cases where Length of Stay  $\leq$  30 days and Discharge Status = Death (or equivalent criteria) to ensure all hospital admissions where the patient dies in hospital within 30 days of admission are identified.

***Explanatory notes:***

- The unit of measurement is a hospital admission, which by definition excludes separate counting of ‘nested admissions’ in the denominator and numerator of the indicator.
- Follow-up period is for 30 days (discharge date – admission date  $\leq$  30 days) starting from the day of admission.
- All causes of death will be considered in identifying valid cases of mortality.
- All deaths related to admissions within the reference period are to be included in the numerator. This means that a 30-day follow-up after the end of the denominator selection period is required for identifying deaths. For example, a patient admitted on the 1st of December 2015 requires follow-up to the 31 December 2015.
- Numerator and denominator cases identified for 2013, 2014 and 2015 will be aggregated to calculate the indicators rates.
- Final rates are indirectly standardized to an OECD reference population using age, sex, and co-morbidity. This reference population is created by aggregating data from all countries participating in the data collection. No attempt to equalize the weight of participating countries in the reference population is made so countries with larger patient populations will have greater influence on the reference population.
- Figure 27 provides a representation of the calculation of the AMI 30-day mortality indicator using unlinked data.

Figure 27. Calculation algorithm for unlinked data-based calculation



#### 4.2. Linked data-based Acute Myocardial Infarction 30 Day Mortality Indicator

##### **Description:**

217. Mortality rate within 30 days for patients being admitted to hospital during a specified three year period with an initial Acute Myocardial Infarction.

##### **Coverage:**

- All government and non-government hospitals providing acute non-elective admissions (i.e. urgent/emergency) during the reference period, including private hospitals.



- All hospital admissions (including elective and non-elective acute, sub-acute, non-acute care admissions) from hospitals providing acute non-elective care during the reference period of 1 January 2013 to 1 December 2015.

***Denominator inclusions:***

- All hospital episodes which include at least one admission (including nested admissions) where Urgency Status = Non-Elective and Care Type = Acute (or equivalent criteria) to ensure only urgent acute care hospitals admissions are included.
- All hospital episodes with at least one admission (including nested admissions) with a principal diagnosis (PDX) of Acute Myocardial Infarction (see following ICD-10-WHO and ICD-9-CM codes).
- All initial AMI admissions (including nested admissions) within each hospital episode. The initial AMI admission can be the first admission of the hospital episode or a subsequent admission, if the AMI occurred during the episode of care.
- All admissions where the age at admission is 45 years and over.

ICD-10-WHO

Code	Description
I21.0	Acute transmural myocardial infarction of anterior wall
I21.1	Acute transmural myocardial infarction of inferior wall
I21.2	Acute transmural myocardial infarction of other sites
I21.3	Acute transmural myocardial infarction of unspecified site
I21.4	Acute subendocardial myocardial infarction
I21.9	Acute myocardial infarction, unspecified
I22.0	Subsequent myocardial infarction of anterior wall
I22.1	Subsequent myocardial infarction of inferior wall
I22.8	Subsequent myocardial infarction of other sites
I22.9	Subsequent myocardial infarction of unspecified site

ICD-9-CM

Code	Description
410.0	Acute myocardial infarction of anterolateral wall
410.1	Acute myocardial infarction of other anterior wall
410.2	Acute myocardial infarction of inferolateral wall
<u>410.3</u>	Acute myocardial infarction of inferoposterior wall
410.4	Acute myocardial infarction of other inferior wall
410.5	Acute myocardial infarction of other lateral wall
410.6	Acute myocardial infarction, true posterior wall infarction
<u>410.7</u>	Acute myocardial infarction, subendocardial infarction
410.8	Acute myocardial infarction of other specified sites
<u>410.9</u>	Acute myocardial infarction, unspecified site

***Denominator exclusions:***

- Same day hospital episodes (where date of admission = date of discharge) where the Discharge Status  $\neq$  Death or equivalent criteria to ensure only same day discharges where the patient is discharged alive are excluded. Given the unit of measurement is a hospital episode there is no need to ensure Discharge Status  $\neq$  Transfer to Hospital for Admitted Care.
- All hospital episodes prior to the last episode meeting the inclusion criteria in the reference period for each patient (i.e. only the last hospital episode is counted).
- Patients who are not residents in the country (e.g. tourists).

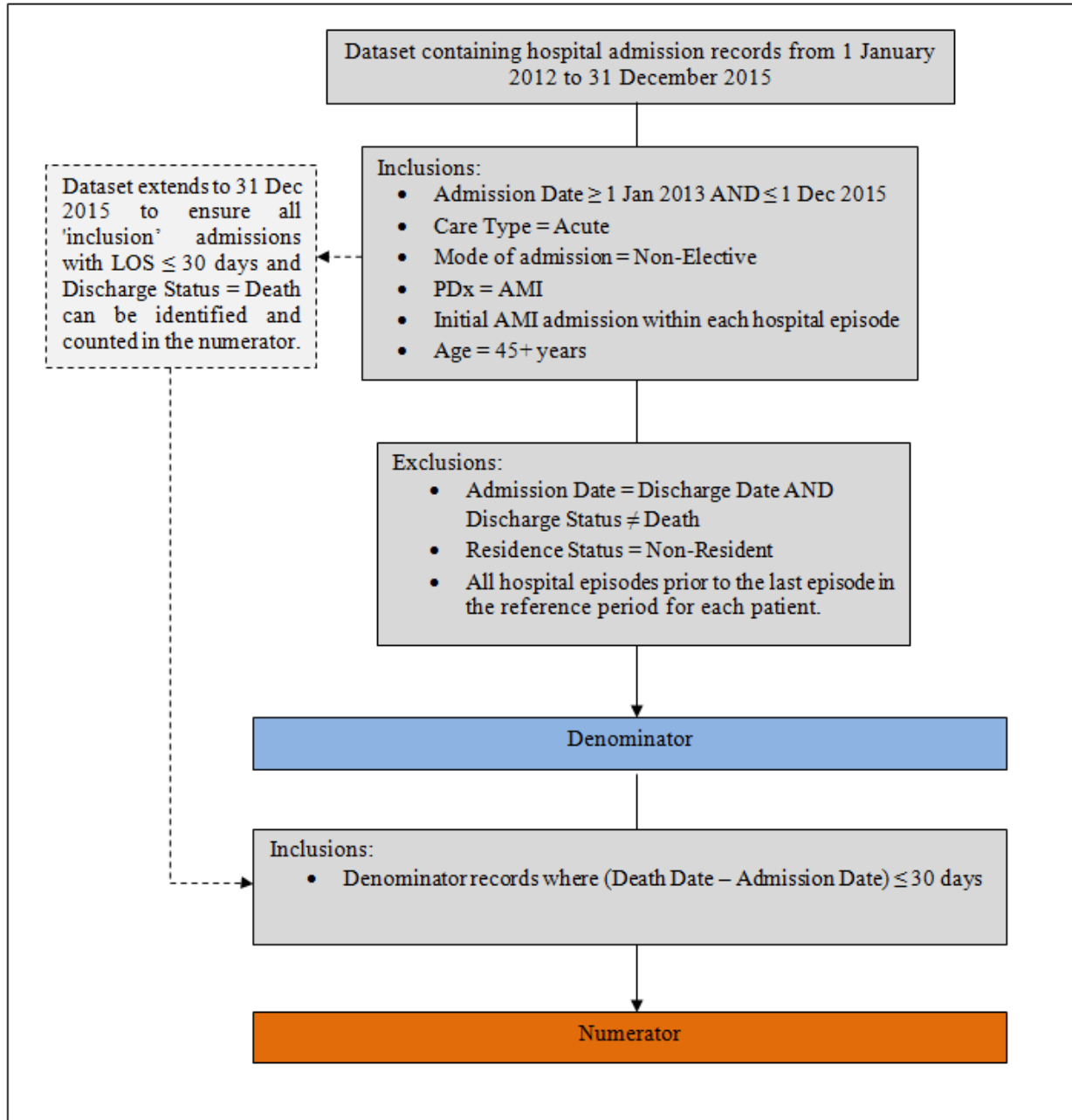
***General numerator inclusions:***

- Numerator cases can only be drawn from the denominator population.
- All denominator cases where (Death Date – Admission Date  $\leq$  30 days) or equivalent criteria to ensure all hospital episodes where the patient dies within 30 days of admission to the hospital episode are identified.

***Explanatory notes:***

- Follow-up period is for 30 days (discharge date – admission date  $\leq$  30 days) starting from the date of the qualifying admission within the hospital episode.
- All causes of death will be considered in identifying valid cases of mortality.
- All deaths related to denominator cases are to be considered for numerator selection. This means that a 30-day follow-up after the end of the denominator selection period is required for identifying deaths.
- Numerator and denominator cases identified for 2013, 2014 and 2015 calendar years will be aggregated to calculate the indicators rates.
- Non-residents are excluded from the calculation of the patient based rates due to the risk of incomplete linkage of records in relation to hospital care and mortality data.
- Final rates are indirectly standardized to an OECD reference population using age, sex, co-morbidity, and previous AMI. This reference population is created by aggregating data from all countries participating in the data collection. No attempt to equalize the weight of participating countries in the reference population is made so countries with larger patient populations will have greater influence on the reference population.
- Figure 28 provides a representation of the calculation of the AMI 30-day mortality indicator using linked data.

Figure 28. Calculation algorithm for linked data-based calculation



## Bibliography

- Belicza, E. (2012) European Health Care Outcomes, Performance and Efficiency Project (EuroHOPE) EuroHOPE Discussion Papers No 5 accessed at [http://www.eurohope.info/doc/EHDP5\\_AMI.pdf](http://www.eurohope.info/doc/EHDP5_AMI.pdf) on 20 January 2016.
- BridgeHealth (2017) WP11 – Quality of Performance Information: Comparison of feasibility and quality of performance information calculated from administrative data sets, European Union.
- Carinci F, (2009) The BIRO Project, in "The BIRO Consortium. Best Information through Regional Outcomes: a Shared European Diabetes Information System for Policy and Practice, University of Perugia, Perugia, 2009", pag.15. Available at: [http://www.eubirod.eu/academy/monograph/BIRO\\_Monograph.pdf](http://www.eubirod.eu/academy/monograph/BIRO_Monograph.pdf). Accessed 16th Nov 2015
- European Collaboration for Healthcare Optimization (ECHO) (2014) Handbook on methodology: ECHO indicators accessed at [http://www.echo-health.eu/handbook/CV\\_PCI\\_MORT.html](http://www.echo-health.eu/handbook/CV_PCI_MORT.html) on 20 January 2016.
- OECD (2017), *Health at a Glance 2017: OECD Indicators*, OECD Publishing, Paris. [http://dx.doi.org/10.1787/health\\_glance-2017-e](http://dx.doi.org/10.1787/health_glance-2017-e)
- OECD (2015), *Health Data Governance: Privacy, Monitoring and Research*, OECD Health Policy Studies, OECD Publishing, Paris. <http://dx.doi.org/10.1787/9789264244566-en>
- Quan H, Sundararajan V, Halfon P, et al. Coding algorithms for defining Comorbidities in ICD-9-CM and ICD-10 administrative data. *Medical Care*. 2005 Nov; 43(11): 1130-9 accessed at <http://mchp-appserv.cpe.umanitoba.ca/concept/Charlson%20Comorbidities%20-%20Coding%20Algorithms%20for%20ICD-9-CM%20and%20ICD-10.pdf> on 20 January 2016
- Quan H, Li B, Couris CM, et al. (2011) ‘Updating and validating the Charlson comorbidity index and score for risk adjustment in hospital discharge abstracts using data from 6 countries’. *American Journal of Epidemiology* 2011;173:676–82.

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