

Chapter 3

National health information infrastructure

National information infrastructure appears strong with all 19 countries reporting national hospital in-patient, mortality, health survey and population data and all countries reporting using some data to regularly monitor health care quality. Further, all report having legislation that speaks to the protection of the privacy of personal information. Following patients through the care pathway, and from one database to another, requires patient identifying information. More than one-half of countries report that their national personal health databases do contain unique patient identifying numbers. Countries are divided, however, with about one-half engaged regularly in data linkage studies to monitor health care quality.

This chapter presents the findings of the 2011/12 OECD study of 19 countries regarding the availability of personal health databases at the national level, the sharing of data across national public authorities, national infrastructure for data linkages and analysis, regional and health care network infrastructure for data linkages, and regular uses of linked data for national health and health care monitoring and research.

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

National information infrastructure is quite strong across the countries participating in this study. All have the legal authority to collect identifiable personal health data and all are collecting identifiable personal health data at a national level. Countries also report no limitation in law affecting the retention of personal health information for their unlinked databases. All countries are legally able to analyse the data they have collected to monitor the public's health and to conduct research.

Many pursue data linkage studies on a regular basis and a number regularly monitor health care quality and the performance of their health system through data linkages. Challenges to pursuing data linkage studies, however, relate to multiple data custodians and the consequent necessity of the sharing of person-level data across different public authorities.

National databases

There is a strong underlying infrastructure for analysis of personal health data within the countries participating in this study (see Annexes A and B). All 19 participating countries have national inpatient hospitalisation data, national mortality data; national population health surveys and a national census or a national population registry (see Annex D, Table D.1). Seventeen have a national cancer registry and mental hospital in-patient data. Sixteen countries have national data for primary health care and formal long-term care. Less common are national data collections on prescription medicines (14) and patient experiences (11). Ten countries have reported one or more other databases that are important to their national data infrastructure. These include emergency care data; clinical quality databases; data on births and congenital anomalies; retirement and disability pension claim data; disease management programme data; sickness fund data; dental care registries; immunisation registries; cancer screening data; and registries for diseases other than cancer.

All countries use their national databases to regularly report on health care quality (Table 3.1, Table D.2). Seventeen countries benefit from their inpatient hospitalisation data and 16 countries benefit from cancer registry data and mortality data to monitor health care quality. Fourteen countries report using mental hospital in-patient data and 13 countries report using population health survey data for health care quality monitoring. Twelve countries monitor health care quality using primary health care data and eleven use prescription medicines data and formal long-term care data. Ten benefit from population census or population registry data (in conjunction with health information). Nine countries benefit from patient experiences data to monitor health care quality and the same number also use other important databases to complement their programme of health care quality monitoring.

Seventeen countries have national data at the level of individuals for mortality (Table D.3). Such data can be organised in a database where each row of the database represents an individual. This type of data is a prerequisite for detailed analysis of risk


factors or determinants of health and health care outcomes and is a prerequisite for data linkage. Sixteen countries have individual-level records in their hospital in-patient data, cancer registry data, population health survey data and population census or population registry data. Fourteen have individual-level data for mental hospital in-patients, 13 have this data for primary care and formal long-term care and twelve have this data for prescription medicines. Seven have individual records for patient experiences.

Table 3.1. **Number of countries reporting linkable data and reporting data use**

	Hospital in-patient data	Primary care data	Cancer registry data	Prescription medicines data	Mortality data	Formal long-term care data	Patient experiences survey data	Mental hospital in-patient data	Population health survey data	Population census or registry data
National database available...	19	16	17	14	19	16	11	17	19	19
Contains records for patients or persons	16	13	16	12	17	13	7	14	16	16
Contains a UPI that could be used for data linkage	14	12	13	12	14	11	1	12	11	11
Contains other identifying variables that could be used for data linkage	14	12	16	12	16	12	3	15	11	15
Is used for data linkage studies	14	10	13	12	15	11	1	8	10	11
Is used regularly for data linkage studies	12	8	11	10	15	6	1	7	7	11
Is used regularly for data linkage studies to <i>monitor health care quality</i>	12	4	11	7	12	4	1	5	4	4

Note: The data custodian should be a national authority and data should be included even when it does not cover 100% of the nation.

Source: OECD HCQI Questionnaire on Secondary Use of Health Data, 2011/12.

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Countries were asked to report for all data available at a national level; even it does not cover 100% of the nation. While the impact of population coverage is minor in some countries, it can introduce significant biases in others. For example, some national databases in Canada are available for a limited number of provinces. In this case, the databases do not reflect the regional diversity of the country but do reflect the heterogeneity within the provincial populations. In the United States, national data on health care encounters may be limited to particular sub-populations, such as individuals enrolled in Medicare (elderly persons) or Medicaid (lower-income persons) health insurance programmes or military veterans. In this case, the data is not representative of the underlying heterogeneity of the population.

National infrastructure for data linkage and analysis

Record linkage involves linking two or more databases using information that identifies the same patient or the same person.* An example would be linking patient records in a hospital database to any death records for the same persons in a mortality database in order to identify patients who died following treatment. A specific type of record linkage, often referred to as deterministic linkage or exact matching, involves using

* Other privacy sensitive uses of personal health data could include the linkage of data for patients to records for close biological relatives or disclosure of aggregated data at a level so detailed that it is possible to identify an individual in more than one database without having first undertaken a data linkage.

a unique identifier or set of identifiers to merge two or more sources of data. In health linkages, the identifier used is often a unique patient identifying number or UPI. When a unique patient identifying number is consistently applied and recorded with few errors, this type of record linkage yields the highest quality and most accurate results, at the lowest cost in terms of person-hours.

Sixteen countries reported a national number that uniquely identifies patients (Table 3.2). In 13 countries, the number is used for health care encounters and other governmental purposes, such as social security and taxation. The *United States* reports the Social Security Number (SSN) as a unique identifying number that can distinguish patients in public health care programmes such as Medicare and Medicaid. The SSN, however, is not used generally for health care encounters in the United States and is therefore not a national identifying number for health care services. In three countries, *Canada*, *Portugal*

Table 3.2. National number that uniquely identifies patients and the main uses of this number

	Name of the unique identifying number	Main uses of the identifying number
Belgium	INSZ NISS	INSZ NISS is a national person identifier (national number) used for various purposes, such as health care, social security, and tax.
Canada	Health Card Number	The provinces and territories assign a health card number that is a unique patient number for all publicly funded health care encounters. There is also a unique Social Insurance Number assigned nationally for tax and social security purposes that is not used for health care.
Denmark	CPR N.R. (Central Person Register Number)	Used for “everything” in relation to national and local governments including health care. Also banks and other business identifications, etc.
Finland	Personal Identity Code	The personal identity code is used in practically all data collections in public services, such as health care, social welfare services, education, justice, etc.
France	Numéro d'identification au répertoire (NIR)	Persons born in metropolitan France and overseas departments are registered on the national directory for the identification of natural persons (RNIPP) and are assigned a registration number (NIR). The NIR is used by medical authorities for the issuance of a “carte vitale”. The NIR is also used for social security.
Italy	TS number	TS number contains both a health number and a tax file number and has nearly universal coverage of the population. It is managed through a publicly owned private company, SOGEI that could be considered as a trusted third party.
Israel	ID number	The ID number is used for tax, social security, education, health, licensing, banking and other identified activities.
Korea	Resident Registration Number	Resident Registration Number (RRN) is assigned to each individual upon his/her birth and contains various information including birth date, gender and location of birth. RRN is used in virtually all aspects of life, including economic activities, for personal identification in various documents and communications in Korea.
Malta	Identification Number ID No	ID No is a unique identification number used throughout the country for all purposes including electoral lists, taxation, social security, etc. It is based on the registration number at the Public Registry.
Norway	National Identification Number	The National Identification Number is used for tax, social security, health records, banking and other purposes.
Poland	PESEL	PESEL number is assigned to all citizens at birth; permanent residents; temporary residents with stays of two months or longer; applicants for an identity card; and other persons where regulations require it.
Portugal	Número de Utente do Serviço Nacional de Saúde	This number is used throughout the country for access to national health service care and benefits.
Singapore	National Registration Identity Card Number (NRIC)	NRIC is used for identification, government procedures, and some commercial transactions (e.g. the opening of a bank account).
Sweden	Personnummer (Personal Identity Number)	Personnummer is the main identifier used for all official purposes in Sweden (tax, social welfare, health care, living conditions, education and so on).
United Kingdom	NHS number Scotland also has the Community health index (CHI) number	Everyone registered with the National Health Service in England, Scotland and Wales is issued a unique NHS number. The NHS number is not used for tax/social security purposes. In Scotland, the CHI system was set up for administrative purposes to track patients registering with GPs.
United States	Social Security Number	The SSN is issued to US citizens, permanent residents, and temporary (working) residents and its main purpose is for taxation.

Source: OECD HCQI Questionnaire on Secondary Use of Health Data, 2011/12 and, for Italy, follow-up telephone interview, October 2011.

and the *United Kingdom*, the identifying numbers are exclusive to the provision of health services and are not used for taxation and social security. In *Canada*, the provincial HIN will change when individuals move province and there is no linkage of old to new HIN numbers across provinces. As a result, record linkage studies that depend on the health insurance number might be affected by inter-provincial mobility. UK respondents to the telephone interview for this study were not sure if the NHS number issued to UK residents is a unique number that would be maintained when an individual moved within the United Kingdom or if it would change if an individual moved country within the United Kingdom, producing a similar bias to that experienced in Canada.

Fourteen countries reported a unique identifying number for patients exists currently within their national hospitalisation databases and mortality databases and that this number could potentially be used for data linkage (Table D.4). Thirteen countries reported the same conditions for their cancer registry and twelve for their primary care data, prescription medicines data and mental hospital in-patient data. Eleven reported the same conditions for their formal long-term care data, population health survey data and population census or registry data. Only one country, however, had a unique identifying number that could be used for data linkage of patient experiences data.

France reports the use of different unique patient identifying numbers and that this is a barrier to some data linkage projects. The identifying numbers used by hospitals may vary across hospitals and are different from the identifying numbers used for medical insurance. France has been working on establishing a national identifying number for medical records and this development was approved by law in 2007. Such a number would enable patients to be assured that when electronic medical records are exchanged among providers; health care providers are receiving the correct record for them. Medical insurance records, however, currently depend on a different unique identifier, the NIR, which is the country's social security number. The NIR was considered to be too sensitive to be used for electronic medical records. Options being explored to overcome the difficulty of linking databases include the establishment of a third party who could hold the key that would enable health insurance records with an anonymised NIR to be linked with medical records with the new health identifying number. Another possibility would be to have the insurance system adopt the same identifying number as that used for medical records. Data protection, health insurance and other authorities are working together to determine the best solution.

There are new developments in three countries that have not been able to use a unique identifying number for record linkages, *Switzerland*, *Germany* and *Japan*. The current process in Switzerland involves the health care providers in the Swiss Cantons, who have access to patient names, dates of birth and sex, to create an encrypted identifier that cannot be reversed to reveal the identity of a person. The same algorithm is applied throughout the country and through time and is provided to the Federal Statistical Office (FSO) who uses it to enable data linkages. The algorithm has limitations. In particular, it does not account for name change, which creates a systematic bias in the data, particularly for women, where changes in marital status may result in name changes. There is a unique Social Security Number (SSN) in Switzerland that could potentially be used for data linkage in the future in an encrypted form. Recently, the Swiss Federal Statistical Office (FSO) sought an opinion of the Swiss national Office of Data Protection to determine if the FSO had the legal authority to process data using the SSN. The determination was that this use is in compliance with the health insurance law and could

be in compliance with the law authorising the FSO, if the FSO amends the ordinance that accompanies its authorising legislation that specifies the data that the FSO is collecting. The FSO is pursuing this change in its ordinance. In *Japan*, there is a current proposal to introduce a uniform identifying number for tax and social security purposes, including health care. In *Germany*, a health insurance number, incorporating a unique and unchangeable code for identifying insured persons, is already mandatory within the health insurance system. This number has also been used to support data exchange. In future, this health insurance number is likely to be used in all areas of care provision, once the electronic health card (eGK) has been introduced throughout the country.

Other variables in a database can also be used to link records through a process of exact matching or through probabilistic matching. For probabilistic matching, a set of possible matches among the data sources to be linked are identified. For example, identifying information such as names, dates of birth and postal codes, may be used to assess potential matches. Then statistics are calculated to assign weights describing the likelihood that the records match. A combined score represents the probability that the records refer to the same individuals. Often there is one threshold above which a pair is considered a match, and another threshold below which it is considered not to be a match. This technique is used when an exact match between records across databases is not possible, or when data capture errors have caused deterministic matches to fail.

More countries reported having a set of identifying variables within their databases that could be used for record linkage than reported having a unique patient identifying number (Table D.5). These variables included names, dates of birth, addresses or postal codes, sex, and dates of events. Not all of these identifying variables are available on all of the data, but all of the data have at least some of these identifiers. Sixteen countries reported having a set of identifying variables within their cancer registry and mortality databases. Fifteen reported these variables within their mental hospital in-patient data and within their population census or registry. Fourteen reported these are part of their hospital in-patient data. Twelve reported these within primary care, prescription medicines, and formal long-term care data and eleven reported these within population health survey data. Only three reported such identifiers within patient experiences data.

In Australia, data linkage and data integration are predominantly undertaken through probabilistic means involving a set of potential identifiers, such as name, birth date, sex, and sometimes address. While the two large national health insurance databases [under the Medicare Benefits Schedule (MBS) and the Pharmaceutical Benefits Scheme (PBS)] have Medicare numbers, these numbers have not generally been used for linkage as the number is often not available on other databases and there are legal restrictions to its use. Specifically, there are legal restrictions concerning the linkage of MBS data to PBS data. Hospitalisation data in Australia at the national level are held by the Australian Institute of Health and Welfare. National hospitalisation data lack personal identifying information to permit data linkage, although state government data sets may hold this information. Hence, any project requiring access to identifiable hospitalisation data in Australia requires seeking access to hospitalisation data from the relevant Australian State. In 2010, Australia introduced unique patient identifying numbers, however participation in e-health is not compulsory and the use of e-health numbers for data linkages has not been approved.

Sub-national infrastructure for data linkage projects

In some countries, data linkage is commonly undertaken at the level of regions, states or within specific networks of health care organisations. Networks of health care organisations, such as the US health care organisation network Kaiser Permanente, offer a broad range of health care services and can conduct research where patient data is linked across the different health care facilities they operate.

Eleven countries reported sub-national data linkage activity at the state or region level (Table D.6). *Canada* reported regular health-related data linkage activity across all the major types of health data in nine of the ten Canadian provinces and involving a unique patient identifying number, the provincial Health Information Number. Canada also reported that these provinces have a broader range of projects using data linkage because the provinces have access to more detailed and comprehensive data than is available nationally.

Similarly, *Australia* reported data linkage centres in almost all Australian States and Territories, where data linkage projects are being conducted with a broader array of health and social data than is possible at the national level. Also, a wider array of databases at the state level contain unique person identifying numbers that can be used to support data linkages and data integration. States have been better positioned to advance research based on data linkage due to less complex legislative and organisational restrictions than exist at the national level. The Population Health Research Network, with funding from the Australian Government, is building the infrastructure for record linkage in all states and territories and also at the national level.

Germany reported data linkage project activity at the state level involving cancer registry, mortality, population health survey and other data. Examples include projects related to the development of a mortality index in Bremen State; sickness fund data linkages in Hessen; and linkages involving population health surveys in Augsburg and Essen. The states of Bremen and Hessen are undertaking health-related data linkage studies on a regular basis. These state-level linkages benefit from unique patient identifying numbers. Also, legal provisions allow data from a “morbidity-oriented risk adjustment scheme” of the statutory health insurance system, conducted at the state level, to be analysed at the federal level for health services research and to advance the health insurance system. *Portugal* and *Japan* reported sub-national infrastructure for data linkages within cancer registries.

Sweden also reported data linkage activity within some of the 21 county councils, such as the Skåne Region and the West Region and that these regions are able to undertake a broader range of data linkage activities than can be undertaken at a national level. For example, the West Region has a primary care register that may be linked.

The *United States* reports that each state (plus DC) has a wide variety of data users, data sources and products and may well be undertaking data linkage projects. Further, states have Social Security Numbers that might be used to facilitate linkages along with Medicaid identifiers. Whether or not the states are undertaking a broader range of data linkage activities than are taking place at the national level cannot be determined without an extensive survey. However, the medical and health services literature shows a wide variety of research studies by government, academia, health care quality organisations and industry in the United States.

The *United Kingdom* also reports sub-national data linkage activity in the region of Tayside Scotland. This local area does not, however, have a broader range of data linkage

projects than are possible at the national level in Scotland. Data linkage activity was also reported for the Torbay Care Trust in England (see Case study 11).

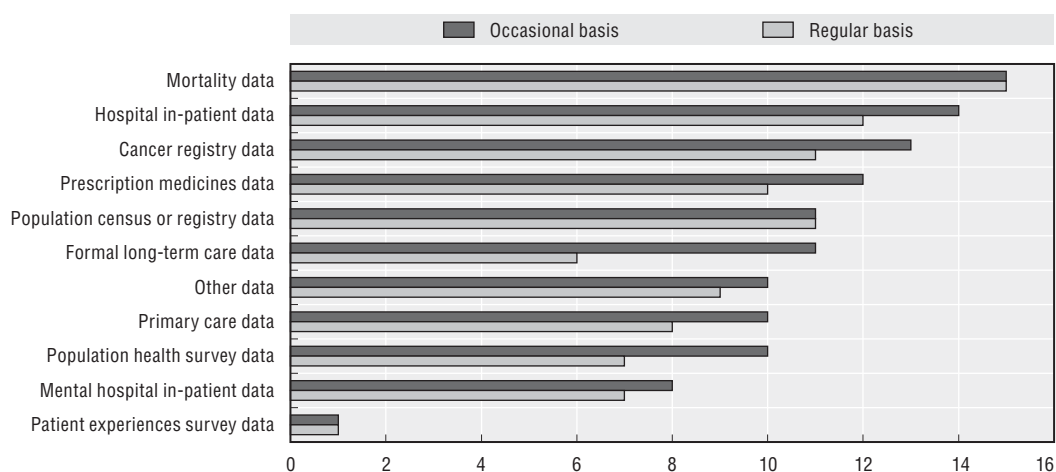
Seven countries, *Belgium, Canada, Germany, Israel, Portugal, Singapore and the United States* reported networks of health care organisations conducting data linkage projects with their own data (Table D.7). Belgium reported this activity within networks of hospitals. Germany reported this activity for several statutory health insurance funds such as Barmer-GEK, AOK and the Bremen Institute for Prevention Research and Social Medicine, BIPS. Israel reported this activity within four national health funds: Clalit, Leumit, Maccabi and Meuhedet. Portugal reported this activity within Integrated Delivery Services. The United States reported this activity among large health care insurers including Kaiser-Permanente, Puget Sound, Harvard Health Plan and others. *Singapore* reported that public health care providers undertake this type of work on an ad hoc basis.

Data linkages for public health research and health care quality monitoring


Most countries with variables within their national databases that would permit data linkages have conducted data linkage projects. Overall, most countries reported record linkage projects involving mortality data, hospital in-patient data, cancer registry data, and prescription medicines data (Table D.8). Half of the countries also reported record linkage studies with all other major types of data, with the exception of patient experience surveys where data linkage has occurred in only one country.

Fewer countries reported undertaking data linkage studies on a regular basis, such that a project was usually underway (Table D.9). Only mortality data was used regularly to support data linkage project in most countries (15 countries). Twelve countries regularly undertook data linkage studies with hospital in-patient data and eleven countries with cancer registry data and population census or registry data. Less common were regular data linkage studies with primary care data (eight countries); population health survey data (seven countries); mental hospital in-patient data (seven countries); and formal long-term care data (six countries). Only one country reported regular data linkage activity with patient experience data.

Figure 3.1. **Number of countries reporting national data used to conduct record-linkage projects on an occasional and on a regular basis**



Source: OECD HCQI Questionnaire on Secondary Use of Health Data, 2011/12.

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Seven countries have a regular occurrence of data linkage projects involving many national databases (Denmark, Finland, Israel, Korea, Sweden, the United Kingdom and the United States). In all but one of these countries, a unique patient identifying number is available to facilitate the linkages (Tables 3.1 and 3.3). The United States relies more on sets of patient identifying information to establish links. Australia, Belgium, France and Switzerland also undertake projects involving the linkage of several databases on a regular basis. Belgium and France have greater ability to conduct these linkages using a unique patient identifying number, while other identifiers are more often used in Australia and Switzerland. Belgium, Canada, Malta and Norway conduct regular data linkage projects with some databases and use a unique identifying number to undertake the work. Norway (nine databases), Singapore (seven databases), Malta (seven databases) and Portugal (four databases) have national databases with patient identifying numbers and/or other patient identifiers, but engage in data linkage on a regular basis with one-half or fewer of the available databases. Germany, Japan and Poland all have databases with variables that could be used to undertake data linkage projects, but none do so regularly with any of these databases.

Countries are divided, with just over one-half engaged regularly in national data linkage studies to monitor health care quality involving their hospital-inpatient, cancer registry and mortality data and less than half of countries with their prescription medicines data (Table 3.1, Table D.10). Regular linkage studies to monitor the quality of primary health care, mental hospital in-patient care and formal long-term care remain relatively rare, with only 4-5 countries reporting undertaking such work.

Finland reports that hospital in-patient data is linked to formal long-term care data on a regular basis to get complete information on institutionalised care; cancer registry data is combined with mortality data to complete the data with all cancer cases; and data on deaths is combined with the Medical Birth Register and the Register on Congenital Malformations to get more exact information on perinatal and infant deaths. To monitor health care quality, examples include combining registers to get information on the consequences of the use of medicines during pregnancy on the health of newborns; to benchmark hospital health care quality performance for major diseases and medical conditions, such as stroke and very premature births; and to monitor life-expectancy among patients with severe mental health disorders who have been hospitalised. This last project was a multi-country study with other Scandinavian countries.

Table 3.3. Distribution of the regular occurrence of health-related record linkage projects by availability of databases with patient identifiers

	Most national data with a unique patient identifying number (UPI)	Most national data with other patient identifiers	Some national data with a unique patient identifying number (UPI)
Data linkage projects on a regular basis...			
With 7+ national databases	Denmark, Finland, Israel, Korea, Sweden, United Kingdom	United States	
With 5-6 national databases	France, Belgium	Australia	Switzerland
With 3-4 national databases	Canada, Malta, Norway		
With 2 national databases	Singapore		Portugal
None	Japan		Poland, Germany

Source: OECD HCQI Questionnaire on Secondary Use of Health Data, 2011/12.

Israel reports regularly conducting projects involving linkages of mortality data to cancer registrations, long-term care data, mental hospital inpatient data and to data from the census of population. A number of indicators are regularly estimated in order to monitor health care quality. These include 30-day mortality rates after admission to hospital and after procedures within hospital; rates of rehospitalisation; and deaths after discharge from mental health hospitals. Also regularly undertaken are survival analysis and analysis of leading causes of death using linked databases.

Korea reports an extensive programme of regular health care quality monitoring using data linkages. Indicators from the linkage of hospital in-patient data to mortality data include 30-day case fatality for acute myocardial infarction and 30-day post-operative mortality for major types of surgery. Linkages of mental hospital in-patient data to hospital in-patient data enable monitoring hospital re-admissions for mental-health patients; and further linkage to prescription medicines data enable monitoring health outcomes of prescribing to mental-health patients. Outcomes of prescribing patterns in primary care are monitored through linkage of prescription medicines and primary care databases. *Korea* also links the cancer registry data to mortality data to assess the relative survival of cancer patients and links long-term care data to survey data on the activities of daily living to estimate the percentage of patients with reduced activities of daily living.

Sweden also reports a comprehensive programme of data linkages that facilitate health care quality monitoring including regular linkages of all registers to mortality data; linkages of patient registry data to the prescribed drug register; and the cancer register to the patient register. *Denmark* reports a similar data linkage capacity including linkages to more than 50 national clinical quality databases.

The *United Kingdom* has the most comprehensive suite of national data among the countries that participated in this study; however, the coverage of these databases is often limited to one or two of the member countries. In *Scotland*, hospital in-patient data, cancer data, mental hospital in-patient data and mortality data are maintained as a permanently linked database. Prescription data has only recently become available at record level with a UPI in *Scotland* and will now be regularly linked. Population health survey data is used regularly in research linkages in *Scotland*. *Scotland* reports using linkage to monitor outcomes of health care including HEAT targets, such as monitoring readmissions and deaths among coronary heart disease patients. In *England*, hospital data is linked to mortality data on a monthly basis. *England* monitors hospital standardised mortality ratios that will be replaced, in future, with a summary hospital-level mortality indicator (SHMI). Cancer incidence data in *England* is routinely linked to mortality, hospital treatment (surgery and radiotherapy) and, for a proportion of the population, to primary care data. Birth notifications are linked to birth registrations (e.g. to determine prematurity) and to death registrations in *England* and the cancer registry is linked to mortality data. *England* produces a 30-day post-operative mortality rates for patients following colorectal cancer surgery. In *England* and *Wales*, the ONS Longitudinal Study (LS) has linked a 1% sample of the population census in 1971, 1981, 1991 and 2001 across censuses and to births, deaths and cancer registrations. The study can be used to understand the distribution of health outcomes by census population characteristics as well as changes in characteristics and health outcomes over time. *Wales* has linked births to hospital delivery records; and the cancer registry to mortality data. The linkage of hospital in-patient data to other databases is under development.

The *United States* reports the regular creation of files linking hospital records, the cancer registry and the population census to mortality data; and population health survey records to mortality data and to health care records for Medicare and Medicaid enrollees. National health care quality monitoring from data linkages includes cancer survival rates, 30-day mortality following in-patient hospitalisations, and infant mortality.

Australia reports that mortality data are linked to cancer registry and diabetes registry data on a regular basis. Data from the population census (conducted every five years) is also regularly linked to mortality data in order to assess under-reporting of Indigenous status on mortality records. Data from the Australian and New Zealand Dialysis and Transplant Registry are linked with mortality data to produce estimates for end-stage kidney disease in support of monitoring quality of care. None of Australia's regularly published Health Performance Indicators, however, currently involve the linkage of administrative databases. There are pilot projects underway that may lead to linkage-based indicators in future. *France* reports regularly undertaking data linkage of primary care data to data on in-patient hospitalisations and to health survey data. France is developing health care quality indicators and does not yet regularly link databases for this purpose.

Switzerland reports the linkage of hospital in-patient data, mental hospital in-patient data, formal long-term care data, mortality data and the population census. *Singapore* reports linking data on hospitalisations to both primary care data and to mortality data on a regular basis for policy analysis. Singapore also uses data linkages to develop regular health care quality monitoring indicators including annual rates of 30-day mortality inside and outside of hospital following hospitalisations for acute myocardial infarction and stroke.

In *Belgium*, hospital data is regularly linked to hospital expenditure data; and cancer registry data is linked to mortality data, to health insurance nomenclature, to hospital in-patient data and to cancer screening. Databases on cystic fibrosis and neuromuscular disease patients are linked to the population register to capture year of birth, district, sex and deaths. Belgium reports data linkages to produce process and outcome indicators for breast, testicular, and rectum cancers with on-going work on oesophagus and stomach cancers. Linkage has also been used to assess GP performance. Belgium also maintains a linked sample of health insurance records to monitor health care consumption and expenditures.

Canada also has a number of national databases that are regularly linked using a unique health care identifying number administered by each province. Hospital in-patient data are often linked to other types of health care including emergency room visits; and population health surveys are routinely linked to in-patient hospitalisation data and to mortality data. At the provincial level, data linkage activity to inform about population health and health care quality is extensive.

Norway regularly undertakes linkages of data from the cancer registry to mortality data and data on prescription medicines to data on hospital in-patients. Data linkages are also used to regularly monitor health care quality. Indicators include annual rates of five-year relative survival after four types of cancer and annual rates of diabetes-related lower extremity amputations. *Malta* regularly links data from the cancer registry to mortality data. Also regularly linked are data on hospitalisations to data within the cancer registry, the congenital abnormalities register and to mortality data. Cancer survival rates are regularly reported to monitor quality of care. *Portugal* reports regularly undertaking projects linking primary care and prescription medicines data.



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