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# The Health Impact of, and access to, New Drugs in Korea

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We perform an econometric assessment of the role that pharmaceutical innovation—the introduction and use of new drugs—has played in improving the health of Koreans, by investigating whether diseases for which more new drugs were launched had larger subsequent increases in longevity and smaller subsequent increases in hospitalization. Drugs launched during 1993-2012 are estimated to have increased mean age at death from all diseases by 1.71 years between 1995 and 2015 and 1.09 years between 2005 and 2015. We also estimate that new drugs increased the five-year relative survival rate from all cancers combined by 23.2 percentage points—78.5% of the total increase—between 1993-1995 and 2011-2015, and that new drugs launched during 2008-2010 reduced the number of hospital days in 2017 by 13.0 million.
If the drugs launched during 2003-2012 had had no effect on other medical expenditure in 2015, the cost per life-year gained would not have exceeded 6332 USD. Therefore, even if we ignore the effect of new drugs on hospital utilization, the drugs launched during 2003-2012 were very cost–effective, overall. When reduced hospital utilization is accounted for, the evidence indicates that, in the long run, pharmaceutical innovation was cost-saving as well as life-year saving.

*Keywords*: Longevity, Pharmaceutical, Innovation, Korea, Hospitalization, Cancer
*JEL Classification*: J11, O33, L65

## I. INTRODUCTION

The health status of Koreans has improved significantly during the past few decades. Life expectancy at birth increased from 78.17 years in 2005 to 82.02 years in 2015. Yang et al. (2010) concluded that rapid increases in life expectancy in South Korea during the period 1970-2005 were mostly achieved by reductions in infant mortality and in diseases related to infections and blood pressure. But reductions in infant mortality account for a very small part of recent increases in life expectancy at birth. The ratio of the 1999-2009 increase in life expectancy at age 1 to the 1999-2009 increase in life expectancy at birth was 96% for males and 93% for females (Statistics

Korea, 2010). Also, the 5-year relative survival rate of Korean patients diagnosed with cancer increased from 41.2% in 1993-1995 to 70.7% in 2011-2015 (Jung et al., 2018).

The purpose of this study is to assess econometrically the role that pharmaceutical innovation—the introduction and use of new drugs—has played in improving the health of Koreans. During the period 1988-2018, 775 new drugs (new molecular entities[1]) were launched in Korea: about 25 new drugs per year, on average.[2] The vast majority of new drugs launched in Korea were developed in other countries. Hence if life-years were gained by Koreans from the launch of new drugs, they might be considered "gains from international trade."

Longevity increase is a very important part of economic growth, broadly defined. Nordhaus (2005) argued that "improvements in health status have been a major contributor to economic welfare over the twentieth century. To a first approximation, the economic value of increases in longevity in the last hundred years is about as large as the value of measured growth in non-health goods and services." There is a consensus among macroeconomists that technological progress (which includes the introduction of new products) is the principal source of economic growth. Jones (2002) argued that "long-run growth is driven by the discovery of *new ideas* throughout the world."[3] Aghion and Howitt (2005) said that "technological progress, the mainspring of long-run economic growth, comes from innovations that generate *new products*, processes and markets." Grossman and Helpman (1991) developed "a model of repeated *product improvements* in a continuum of sectors. Each product follows a

[1] New Molecular Entities (NMEs) are compounds that emerge from the process of medicine discovery, that are not a version or derivative of an existing, previously investigated/approved substance. They have promising activity against a particular target thought to be important in a disease. <https://www.eupati.eu/glossary/new-molecular-entity/> (accessed February 21, 2020) Here are 3 examples of NMEs: (1) Tenofovir, a medication used to treat chronic hepatitis B and to prevent and treat HIV/AIDS, was approved for use in the United States in 2001, and first sold in Korea in 2012. (2) Linagliptin, a medication used to treat diabetes mellitus type 2, was approved for medical use in the United States in 2011, and first sold in Korea in 2016. (3) Sofosbuvir, a medication used to treat hepatitis C, was approved for medical use in the United States in 2013, and first sold in Korea in 2016.

[2] These figures refer to the number of post-1981 new chemical entities (NCEs) launched in Korea. A post-1981 NCE is an NCE that was first launched anywhere in the world after 1981.

[3] The discovery of new ideas could increase economic output for two different reasons. First, output could simply be positively related to the quantity (and variety) of ideas ever discovered. Second, output could be positively related to the (mean or maximum) quality of ideas ever discovered, and new ideas may be better (of higher quality), on average, than old ideas.

stochastic progression up a quality ladder." Bresnahan and Gordon (1996) said that "*new goods* are at the heart of economic progress." As noted by Jovanovic and Yatsenko (2012), in "the Spence–Dixit–Stiglitz tradition…*new goods* [are] of higher quality than old goods" [emphasis added].

Most scholars agree with Jones' (1998, pp. 89-90) statement that "technological progress is driven by research and development (R&D) in the advanced world." Dorsey et al. (2010) showed that, in 2008, 88% of private U.S. biomedical research expenditure was funded by pharmaceutical and biotechnology firms; the remaining 11% was funded by medical device firms.

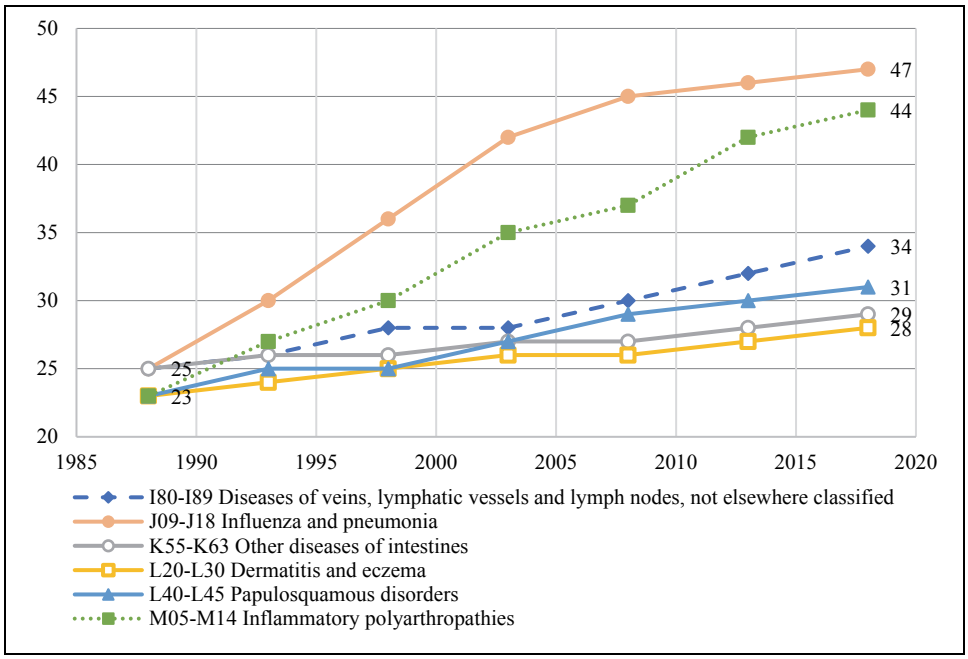
The analysis will be performed using a difference-in-differences (or two-way fixed effects) research design: we will investigate whether diseases for which more new drugs were launched had larger subsequent increases in longevity and smaller subsequent increases in hospitalization. This design controls for the effects of general economic and societal factors (e.g. income, education, and behavioral risk factors), to the extent that those effects are similar across diseases, e.g. smoking increases mortality from respiratory and cardiovascular disease as well as lung cancer, and education reduces mortality from all diseases.

The number of new drug launches varied considerably across diseases. For example, as shown in Figure 1, during the period 1988-2018, 22 new drugs for treating influenza and pneumonia, and 21 new drugs for treating inflammatory polyarthropathies, were launched. Only 5 new drugs for treating dermatitis and eczema, and 4 new drugs for treating other diseases of intestines (ICD-10 block K55-K63), were launched.

We will analyze the impact that new drug launches had on three important health outcomes: (1) mean age at death from all types of diseases; (2) cancer survival rates; and (3) hospitalization from all types of diseases. We will also provide evidence about how access to new drugs in Korea compares to access in other "high-income" (as defined by the World Bank) countries.

In the next section, we will describe the econometric models that we will use to assess the role that pharmaceutical innovation played in reducing mortality and hospitalization in Korea. The data sources used to estimate these models are discussed on Section III. Empirical results are presented in Section IV. Some implications of the estimates, and evidence about access to new drugs in Korea, are discussed in Section V. Section VI provides a summary.

Figure 1. Number of Drugs used to Treat 6 Diseases ever Launched in Korea, 1988-2018




Source: Author's calculations based on data contained in Theriaque database and IQVIA New Product Focus and MIDAS databases.

## II. METHODS

### *1. Mean Age at Death from All Types of Diseases*

To assess the impact that pharmaceutical innovation had on mean age at death from all types of diseases, we will estimate models based on the following 2-way fixed effects equation:

$$AGE\_DEATH_{dt} = \beta_k \, CUM\_DRUG_{d,t-k} + \alpha_d + \delta_t + \varepsilon_{dt} \qquad (1)$$

where

$AGE\_DEATH_{dt}$ = mean age at death from disease d in year t (t = 1995, 2005, 2015)

$CUM\_DRUG_{d,t-k} = \sum_m IND_{md} LAUNCHED_{m,t-k}$ = the number of chemical substances to treat disease d that had been launched in Korea by the end of year t-k (k = 0, 1, 2,…)

$IND_{md}$ = 1 if chemical substance m is used to treat (indicated for) disease d [4]
= 0 if chemical substance m is not used to treat (indicated for) disease d

$LAUNCHED_{m,t-k}$ = 1 if chemical substance m had been launched in Korea by the end of year t-k
= 0 if chemical substance m had not been launched in Korea by the end of year t-k

$\alpha_d$ = a fixed effect for disease d

$\delta_t$ = a fixed effect for year t

Eq. (1) may be considered a health production function (Koç, 2004), and the number of chemical substances ever launched may be considered a measure of the stock of pharmaceutical "ideas."

The measure of longevity that is the dependent variable in eq. (1) is mean age at death. An alternative, and better known, measure of longevity is life expectancy at birth.[5] Mean age at death can be computed for specific diseases, whereas life expectancy at birth cannot. However, the 2005-2015 change in life expectancy at birth is strongly positively correlated (p-value < .0001) across countries with the 2005-2015 change in mean age at death (from all diseases combined). Appendix Figure 1 shows a bubble plot of this relationship based on data for 35 European countries.

The launch of a drug indicates that patients *could* have been treated with that drug, not necessarily that patients *were* treated with that drug. We would prefer to estimate models in which the explanatory variables measured the drugs *actually used* to treat

[4] Many drugs have multiple indications: 50% of drugs have 2 or more indications (causes of disease in the WHO Global Health Estimates disease classification), and 7% of drugs have 5 or more indications.

[5] Mean age at death represents the actual mean age at which patients died in a given year. Life expectancy at birth represents the hypothetical mean number of years until death of patients born in a given year.

patients, by disease, and year. We have annual data for 2007-2017 on the utilization of each drug in Korea. However, many drugs have multiple indications—50% of drugs have 2 or more indications (causes of disease in the WHO Global Health Estimates disease classification), and 7% of drugs have 5 or more indications—and our data do not enable us to determine how often each drug was used for each of its indications.

Since patients can access drugs that have been included in the National Health Insurance System (NHIS) of Korea with less financial burden, it might also be preferable to replace $CUM\_DRUG_{d,t-k}$ with $CUM\_NHIS_{d,t-k}$, where $CUM\_NHIS_{d,t-k}$ = the number of chemical substances to treat disease d that had been included in the NHIS by the end of year t-k. Unfortunately, we were unable to obtain data on the year in which each chemical substance was included in the NHIS.[6] But $CUM\_DRUG_{d,t-k}$ is likely to be fairly highly correlated with $CUM\_NHIS_{d,t-k}$.

Since our drug launch variables are imperfect measures of exposure to pharmaceutical innovation, the estimated coefficients on those variables are likely to be biased towards zero, and our estimates of the number of life-years saved by new drugs are likely to be conservative. Here is the first paragraph of the eminent MIT econometrician Jerry Hausman's (2001 p. 57) article on mismeasured variables in econometric analysis:

> The effect of mismeasured variables in statistical and econometric analysis is one of the oldest known problems, dating from the 1870s in Adcock (1878). In the most straightforward regression analysis with a single regressor variable, the least squares estimate is downward biased in magnitude toward zero. While a mismeasured right-hand side variable creates this problem, a mismeasured left-hand side variable under classical assumptions does not lead to bias. The only result is less precision in the estimated coefficient and a lower t-statistic.

Due to data limitations, $CUM\_DRUG_{c,t-k}$ is the only disease-specific, time-varying regressor in eq. (1). If the data were available, we would like to include other regressors in eq. (1), e.g. the number of non-pharmaceutical medical innovations (e.g. medical device innovations) that had been launched in Korea.[7] Failure to control for non-

[6] Those data may be available upon request to the NHIS.

[7] Some major studies have not found there to be health benefits of some nonpharmaceutical innovations. A large U.S. government study found that drug therapy alone may save lives as effectively as bypass or stenting procedures (Kolata, 2019). Also, data from the Prostate, Lung, Colorectal and Ovarian randomized screening trial showed that, after 13 years of follow up, men who underwent annual prostate cancer screening with prostate-specific antigen testing and digital

pharmaceutical medical innovation (e.g. innovation in diagnostic imaging, surgical procedures, and medical devices) is also unlikely to bias estimates of the effect of pharmaceutical innovation on the burden of disease, for two reasons. First, as noted earlier, 88% of privately-funded U.S. funding for biomedical research came from pharmaceutical and biotechnology firms (Dorsey et al., 2010).[8] Second, previous research based on U.S. data (Lichtenberg, 2014a; 2014b) indicated that non-pharmaceutical medical innovation is not positively correlated across diseases with pharmaceutical innovation. Third, a study of pharmaceutical innovation and longevity growth in 30 developing and high-income countries during the period 2000-2009 (Lichtenberg, 2014c) found that controlling for ten other potential determinants of longevity change (real per capita income, the unemployment rate, mean years of schooling, the urbanization rate, real per capita health expenditure (public and private), the DPT immunization rate among children ages 12-23 months, HIV prevalence and tuberculosis incidence) *increased* the estimated effect of pharmaceutical innovation on life expectancy by about 32%.

We will use data for three years: 1995, 2005 and 2015.[9] Substituting the first and last values of t into eq. (1) yields:

$$AGE\_DEATH_{d,1995} = \beta_k \, CUM\_DRUG_{d,1995\text{-}k} + \alpha_d + \delta_{1995} + \varepsilon_{d,1995} \quad (2)$$

$$AGE\_DEATH_{d,2015} = \beta_k \, CUM\_DRUG_{d,2015\text{-}k} + \alpha_d + \delta_{2015} + \varepsilon_{d,2015} \quad (3)$$

Subtracting eq. (2) from eq. (3) yields:

$$\Delta AGE\_DEATH_d = \beta_k \, \Delta CUM\_DRUG\_k_d + \delta + \varepsilon_d' \quad (4)$$

where

rectal examination had a 12 percent higher incidence of prostate cancer than men in the control group but the same rate of death from the disease. No evidence of a mortality benefit was seen in subgroups defined by age, the presence of other illnesses, or pre-trial PSA testing (National Cancer Institute, 2012).

[8] Much of the rest came from the federal government (i.e. the NIH), and new drugs often build on upstream government research (Sampat and Lichtenberg, 2011). The National Cancer Institute (2019) says that it "has played a vital role in cancer drug discovery and development, and, today, that role continues."

[9] 1995 and 2015 are the first and last years for which the ICD10 disease classification was used in available Korean mortality data.

$$\Delta AGE\_DEATH_d = AGE\_DEATH_{d,2015} - AGE\_DEATH_{d,1995}$$

$$\Delta CUM\_DRUG\_k_d = CUM\_DRUG_{d,2015-k} - CUM\_DRUG_{d,1995-k}$$

$$\delta = \delta_{2015} - \delta_{1995}$$

$$\varepsilon_d' = \varepsilon_{d,2015} - \varepsilon_{d,1995}$$

Eq. (4) is a simple regression of the 20-year (1995-2015) *change* in mean age at death from disease d on the change in the number of drugs that were used to treat disease d that had ever been launched k years earlier, i.e. on the number of drugs used to treat disease d that were launched during the years 1995–k+1 to 2015-k.[10] The intercept of eq. (4) is an estimate of the change in mean age at death in the absence of pharmaceutical innovation (i.e. if mean (ΔCUM_DRUG_k) = 0), so [mean (ΔAGE_DEATH) - δ] is an estimate of the increase in mean age at death attributable to pharmaceutical innovation. To address the issue of heteroskedasticity, eq. (4) will be estimated by weighted least squares, weighting by $1/((1/N\_DEATHS_{d,1995}) + (1/N\_DEATHS_{d,2015}))$, where $N\_DEATHS_{dt}$ = the number of deaths caused by disease d in year t. The diseases are ICD-10 blocks, e.g. I00-I02 Acute rheumatic fever or J09-J18 Influenza and pneumonia).

In addition to estimating models of the 20-year (1995-2015) change in mean age at death, we will estimate models of the 10-year (2005-2015) change in mean age at death.

There is likely to be a lag between the launch of a new drug and its maximum impact on mean age at death. Utilization of recently-launched drugs tends to be much lower than utilization of drugs launched many years earlier. Evidence about the shape of the drug-age (number of years since launch) drug-utilization profile can be obtained by estimating the following equation:

$$\ln(N\_SU_{mn}) = \rho_m + \pi_n + \varepsilon_{mn} \quad (5)$$

where

$N\_SU_{mn}$ = the number of standard units of molecule m sold in Korea n years after it was first launched (n = 0, 1,…, 20)

[10] The parameter δ in eq. (4) is an estimate of the change in mean age at death in the absence of any drug launches between 2005 – k and 2015 – k.

$\rho_m$ = a fixed effect for molecule m

$\pi_n$ = a fixed effect for age n

The expression $\exp(\pi_n - \pi_{10})$ is a "relative utilization index": it is the mean ratio of the quantity of a drug sold n years after it was launched to the quantity of the same drug sold 10 years after it was launched. We estimated eq. (5), using annual data for the period 2007-2017 on 631 molecules. Estimates of the "relative utilization index" are shown in Figure 2. These estimates indicate that utilization of a drug reaches a peak about 16-18 years after it was launched. It is used about twice as much then as it was 3-4 years after launch.[11,12]

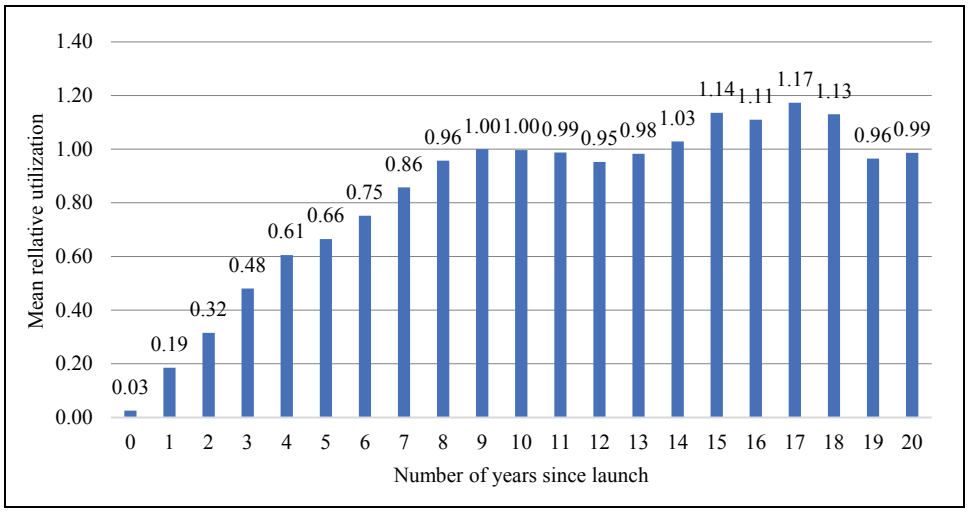
Due to gradual diffusion of new drugs, the maximum impact of a drug on mean age at death is likely to occur years after it was launched, but the peak effect could occur either more than or less than 16-18 years after launch. The lag might be longer because some drugs for chronic diseases (e.g. statins) may have to be consumed for several years to achieve full effectiveness. But the lag might be shorter because the impact of a drug on mean age at death is likely to depend on its quality (or effectiveness) as well as on its quantity (utilization), and drugs launched more recently are likely to be of higher quality than earlier-vintage drugs.[13]

[11] The estimate of a 16-18 year lag from drug launch to peak drug utilization in Korea is 8 years longer than the average 8-10 year lag in 22 countries (Australia, Austria, Belgium, Brazil, Canada, Switzerland, Chile, Colombia, Germany, Ecuador, Spain, Finland, France, United Kingdom, Ireland, Italy, Japan, Mexico, Portugal, Singapore, Sweden, and the U.S.) estimated in Lichtenberg (2018).

[12] Diffusion of cancer (WHO ATC anatomical main group L) drugs is slower than diffusion of drugs in general: cancer drugs are used 6 times as much 16-18 years after launch as they are 3-4 years after launch.

[13] The impact on mortality may depend on the interaction (quantity * quality) of the two variables. The mortality impact will increase with respect to drug age (time since launch) if the rate of increase of quantity with respect to age is greater than the rate of decline of quality with respect to age; otherwise the mortality impact will decline.

Figure 2. Mean Ratio of Quantity of a Drug Sold k Years after Launch to Quantity of the Same Drug Sold 10 Years after Launch




## *2. 5-year Relative Cancer Survival Rates*

To assess the impact that pharmaceutical innovation had on 5-year relative cancer survival rates, we will estimate models based on the following 2-way fixed effects equation:

$$\ln(SURV_{st}/(1 - SURV_{st})) = \beta_k \ln(CUM\_DRUG_{s,t-k}) + \alpha_s + \delta_t + \varepsilon_{st} \quad (6)$$

where

$SURV_{st}$ = the 5-year relative survival rate of patients diagnosed with cancer at cancer site s (breast, colon, lung, etc.) between year t and year t+2 or t+4 (t = 1993, 1996, 2011)[14]

$CUM\_DRUG_{s,t-k}$ = the number of chemical substances to treat cancer at site s that had been launched in Korea by the end of year t-k (k = 0, 1, 2,…)

[14] The survival rates cover three periods: patients diagnosed in 1993-1995, 1996-2000, and 2011-2015.

The following model of the 19-year (1993-1995 to 2011-2015) *change* in the log-odds of cancer survival can be derived from eq. (6):

$$\ln(SURV_{s,2011}/(1-SURV_{s,2011})) - \ln(SURV_{s,1993}/(1-SURV_{s,1993})) = \beta_k [\ln(CUM\_DRUG_{s,2011-k}) - \ln(CUM\_DRUG_{s,1993-k})] + \delta + \varepsilon_s' \quad (7)$$

We will also estimate a similar model of the 15-year (1996-2000 to 2011-2015) change in the log-odds of cancer survival. To address the issue of heteroskedasticity, eq. (7) will be estimated by weighted least squares, weighting by $1/((1/INCIDENCE_{s,1999}) + (1/INCIDENCE_{s,2015}))$, where $INCIDENCE_{st}$ = the age-standardized incidence rate of cancer at site s in year t. Jung et al. (2018)'s cancer site classification will be used.

### *3. Hospital Utilization*

Studies have shown that new drugs for Crohn's disease, transthyretin amyloid cardiomyopathy, and some types of cystic fibrosis have reduced hospitalization:

- Data from the Phase 3 IM-UNITI study showed that treatment with ustekinumab lowered the risk of Crohn's disease (CD)-related hospitalization, surgery, and the need for alternative biologic therapy in patients with moderate-to-severe CD when compared with placebo. At 2 years, patients in the ustekinumab q12w group were 52% less likely to be hospitalized or require surgery vs patients in the placebo group (hazard ratio [HR] 0.477; 95% CI, 0.238, 0.957; P =.033). Patients in the ustekinumab q8w group were 40% less likely to be hospitalized or require surgery (HR 0.601; 95% CI, 0.411, 0.879; P =.006).[15]
- A phase three clinical trial has shown that tafamidis significantly reduces deaths and hospitalizations in patients with transthyretin amyloid cardiomyopathy, a progressive form of heart failure. Compared to a placebo, the drug reduced deaths by 30 percent and reduced cardiovascular-related hospitalizations by 32 percent.[16]
- Ivacaftor is a small molecule drug originally developed to treat the G551D CFTR gene variant that causes about 3-4% of Cystic fibrosis (CF) cases. Inpatient

[15] <https://www.empr.com/news/stelara-ustekinumab-crohns-disease-hospitalization-surgery-reduction-im-uniti/article/770888/> (accessed February 21, 2020)

[16] <https://www.nyp.org/news/Drug-Reduce-Deaths-Hospitalizations-Underdiagnosed-Heart-Failure> (accessed February 21, 2020)

admissions decreased by 55% from 0.57 inpatient admissions per person-year pre-ivacaftor to 0.26 admissions post-ivacaftor, with similar decreases for children and adults.[17]

Other studies have provided more general evidence about cost offsets from prescription drug innovation. Lichtenberg (2009) analyzed the impact of pharmaceutical innovation on hospitalization for a single (albeit important) disease—cardiovascular disease—in 20 OECD countries during the period 1995-2003. Lichtenberg (2014d) analyzed the impact of pharmaceutical innovation on hospitalization for 131 medical conditions in a single country—the United States—during the period 1996-2010. The measure of pharmaceutical innovation used in both studies was the mean *vintage* of prescription drugs, i.e. the utilization-weighted mean world launch year (or FDA approval year) of drugs consumed. Both studies found that pharmaceutical innovation reduced hospitalization, and that the reduction in hospital cost from the use of newer drugs was considerably greater than the innovation-induced increase in pharmaceutical expenditure.

To assess the impact that pharmaceutical innovation had on hospital utilization in Korea, we will estimate models based on the following 2-way fixed effects equation:

$$\ln(DAYS_{dt}) = \beta_k \ln(CUM\_DRUG_{d,t-k}) + \alpha_d + \delta_t + \varepsilon_{dt} \quad (8)$$

where

$DAYS_{dt}$ = the number of days of hospital care[18] provided to patients with diagnosis d in year t (t = 2014, 2017)[19]

The following model of the 3-year *change* in hospital utilization can be derived from eq. (8):

[17] <https://blogs.cdc.gov/genomics/2018/05/08/evaluating-the-impact/> (accessed February 21, 2020)

[18] The number of days of hospital care equals the number of hospital discharges (or admissions) times average length of stay.

[19] Due to a change in the data source, there was a break in the hospital time series in 2014. From 2014, administrative data (the Health Insurance Review & Assessment Service, Statistics of Health Care Utilization) were used. Until 2013, patient survey data (The Patient Survey Report, produced by the Korea Institute for Health and Social Affairs, Ministry of Health and Welfare) were used. See OECD (2019a).

$$\Delta\ln(DAYS_d) = \beta_k \, \Delta\ln(CUM\_DRUG\_k_d) + \delta + \varepsilon_d \text{‘} \quad (9)$$

where

$$\Delta\ln(DAYS_d) = \ln(DAYS_{d,2017}) - \ln(DAYS_{d,2014})$$

$$\Delta\ln(CUM\_DRUG\_k_d) = \ln(CUM\_DRUG_{d,2017\text{-}k}) - \ln(CUM\_DRUG_{d,2014\text{-}k})$$

Eq. (9) will be estimated by weighted least squares, weighting by $1/((1/DAYS_{d,2014}) + (1/DAYS_{d,2017}))$. The disease classification is the Eurostat/OECD/WHO *International Shortlist for Hospital Morbidity Tabulation* (OECD, 2019b).

## III. DATA SOURCES

*Drug launch data.* Data on the years in which post-1981 new chemical entities were first launched in Korea were obtained from IQVIA's *New Product Focus* database. Coverage of Korea began in 1988.

*Drug indications data.* Indications (coded by ICD-10) of chemical substances were obtained from Thériaque, a database produced by the French Centre National Hospitalier d'Information sur le Médicament (2019).[20]

*Drug utilization and expenditure data.* Data on the quantity (number of standard units) and value (in USD) of prescription drugs sold in Korea, by chemical substance and year (2007-2017) were obtained from the IQVIA MIDAS database. By combining MIDAS data on which drugs were sold in 2015 and *New Product Focus* data on new drug launches during 1988-2015, we can estimate ("backcast") the number of drugs that had ever been launched for each disease by the end of each year (1987-2015).

*Mortality from all diseases.* Data on mean age at death and the number of deaths were constructed from data obtained from the WHO's Cause of Death Query online database (World Health Organization, 2019), a web-based system for extracting trend series detailed cause-of-death data. Mean age at death increased from 63.6 in 1995 to 68.7 in 2005 and to 73.3 in 2015. Data on mortality and the number of drugs ever launched, by ICD-10 block, are shown in Appendix Table 1.

*Cancer survival and incidence.* Data on cancer survival and incidence rates, by cancer site and year, were obtained from Jung et al. (2018). Data on cancer survival and

[20] Thériaque provides data only on labeled indications; it does not provide data on off-label indications.

incidence rates and the number of drugs ever launched, by cancer site, are shown in Appendix Table 2.

*Hospitalization data.* Data on the number of hospital discharges and average length of stay, by diagnosis and year (2014-2017), were obtained from the *OECD Health Statistics database* **(**OECD, 2019c). Data on hospital utilization and the number of drugs previously launched, by diagnosis, are shown in Appendix Table 3.

## IV. EMPIRICAL RESULTS

### *1. Mean Age at Death from All Types of Diseases*

Estimates of the parameter $\beta_k$ from the model of the 20-year (1995-2015) change in mean age at death from all diseases (eq. (4)) are presented in rows 1-8 of Table 1. Each estimate is from a separate model. The table shows estimates for 8 values (k = 0, 1,…, 6, 7) of the lag (k) from cumulative drug launches to mean age at death. All 8 estimates are positive and statistically significant (p-value < .05).[21] The largest, and most significant, estimate is for k = 3: the 1995-2015 change in mean age at death from a disease is most strongly related to the 1992-2012 change in the number of drugs used to treat the disease ever launched, i.e. to the number of drugs launched during 1993-2012.

The weighted (by $1/((1/N\_DEATHS_{d,1995}) + (1/N\_DEATHS_{d,2015}))$) mean value of ΔAGE_DEATH is 8.39, and the intercept of eq. (4) when k = 3 is 6.67, so the 1995-2015 increase in mean age at death attributable to drugs launched during 1993-2012 is 1.71 (=8.39 – 6.67) years. This is about one fifth (20.4%) of the actual increase in mean age at death during that period. There were 275,854 deaths in Korea in 2015. If drugs launched during 1993-2012 did not affect the total number of deaths or their distribution across diseases, those drug launches increased the number of life-years (or reduced the number of life-years lost) in 2015 by 472,990 (= 1.71 years * 275,854 deaths).

[21] Since Korean drug launch data are not available for years prior to 1988, the longest lag we can estimate is 7 years.

Table 1. Weighted Least-squares Estimates of the Parameter $\beta_k$ from the Model of the Change in Mean Age at Death from All Diseases (eq. (4)): $\Delta AGE\_DEATH_d = \beta_k \Delta CUM\_DRUG\_k_d + \delta + \varepsilon_d$'

| row | k | $\beta_k$ | Standard Error | t Value | Pr > \|t\| |
|---|---|---|---|---|---|
| Dependent variable: change in mean age at death, 1995-2015 | | | | | |
| 1 | 0 | **0.123** | **0.060** | **2.06** | **0.0415** |
| 2 | 1 | **0.134** | **0.059** | **2.26** | **0.0258** |
| 3 | 2 | **0.117** | **0.056** | **2.10** | **0.0383** |
| 4 | 3 | **0.144** | **0.055** | **2.61** | **0.0104** |
| 5 | 4 | **0.127** | **0.052** | **2.45** | **0.0158** |
| 6 | 5 | **0.122** | **0.050** | **2.45** | **0.0159** |
| 7 | 6 | **0.120** | **0.049** | **2.42** | **0.0171** |
| 8 | 7 | **0.110** | **0.048** | **2.30** | **0.0236** |
| Dependent variable: change in mean age at death, 2005-2015 | | | | | |
| 9 | 0 | **0.192** | **0.058** | **3.32** | **0.0013** |
| 10 | 1 | **0.181** | **0.053** | **3.42** | **0.0009** |
| 11 | 2 | **0.178** | **0.051** | **3.52** | **0.0007** |
| 12 | 3 | **0.208** | **0.056** | **3.73** | **0.0003** |
| 13 | 4 | **0.204** | **0.058** | **3.51** | **0.0007** |
| 14 | 5 | **0.177** | **0.052** | **3.43** | **0.0009** |
| 15 | 6 | **0.162** | **0.045** | **3.60** | **0.0005** |
| 16 | 7 | **0.133** | **0.043** | **3.10** | **0.0025** |

N = 104.

Estimates in bold are statistically significant (p-value < .05).

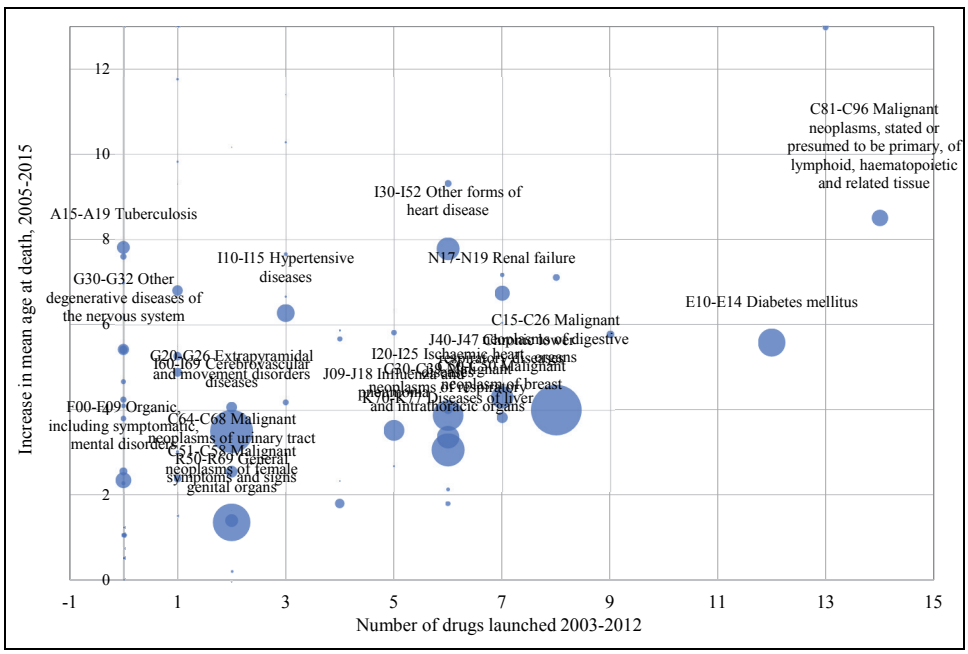
In rows 1-8, observations are weighted by $1/((1/N\_DEATHS_{d,1995}) + (1/N\_DEATHS_{d,2015}))$, where $N\_DEATHS_{dt}$ = the number of deaths caused by disease d in year t. In rows 9-16, observations are weighted by $1/((1/N\_DEATHS_{d,2005}) + (1/N\_DEATHS_{d,2015}))$.

Estimates of the parameter $\beta_k$ from the model of the 10-year (2005-2015) change in mean age at death from all diseases are presented in rows 9-16 of Table 1. Once again, all 8 estimates are positive and statistically significant (p-value < .01), and the most significant, estimate is for k = 3: the 2005-2015 change in mean age at death from a disease is most strongly related to the 2002-2012 change in the number of drugs used to treat the disease ever launched, i.e. to the number of drugs launched during 2003-2012. Figure 3 is a bubble plot of the correlation across diseases between the number of drugs launched during 2003-2012 and the 2005-2015 increase in mean age at death. The estimate of $\beta_3$ in row 12 is 45% larger than the estimate of $\beta_3$ in row 4. A possible explanation for this is that the average quality of drugs launched during 2003-2012 was higher than the average quality of drugs launched during 1993-2002.

The weighted (by $1/((1/N\_DEATHS_{d,2005}) + (1/N\_DEATHS_{d,2015}))$) mean value of $\Delta AGE\_DEATH$ is 4.14, and the intercept of eq. (4) when k = 3 is 3.05, so the 2005-

2015 increase in mean age at death attributable to drugs launched during 2003-2012 is 1.09 (= 4.14 – 3.05) years.[22] Drugs launched during 2003-2012 are estimated to have increased mean age at death by slightly more than one year between 2005 and 2015. This is about one fourth (26.3%) of the actual increase in mean age at death during that period. If drugs launched during 2003-2012 did not affect the total number of deaths or their distribution across diseases, those drug launches increased the number of life-years (or reduced the number of life-years lost) in 2015 by 300,057 (= 1.09 years * 275,854 deaths).

Figure 3. Correlation across Diseases between Number of Drugs Launched during 2003-2012 and 2005-2015 Increase in Mean Age at Death




Bubble area is proportional to (1/((1/N_DEATHS$_{d,2005}$) + (1/N_DEATHS$_{d,2015}$))), where N_DEATHS$_{d,t}$ = the number of deaths due to disease d in year t.

[22] This figure is fairly similar to Lichtenberg's (2014c) 1.27-year estimate of the 2000-2009 increase in life expectancy at birth in 30 developing and high-income countries attributable to pharmaceutical innovation. That study was based on aggregate country-level data on all diseases combined, and the pharmaceutical innovation measure was the increase in the fraction of drugs consumed that were launched after 1990.

## *2. 5-year Relative Cancer Survival Rates*

Estimates of the parameter $\beta_k$ from the model of the 19-year (1993-1995 to 2011-2015) change in the log-odds of cancer survival (eq. (7)) are presented in rows 1-7 of Table 2. For $k \leq 3$, the estimates are not statistically significant. However, the estimates of $\beta_4$, $\beta_5$ and $\beta_6$ are positive and highly significant.[23] The 19-year change in the log-odds of cancer survival is most strongly related to the log change in the number of drugs ever launched 6 years earlier. Figure 4 is a bubble plot of the correlation across cancer sites between the 1988-2003 log change in the number of drugs ever launched and the log change in the 5-year relative survival rate, 1996-2000 to 2011-2015.

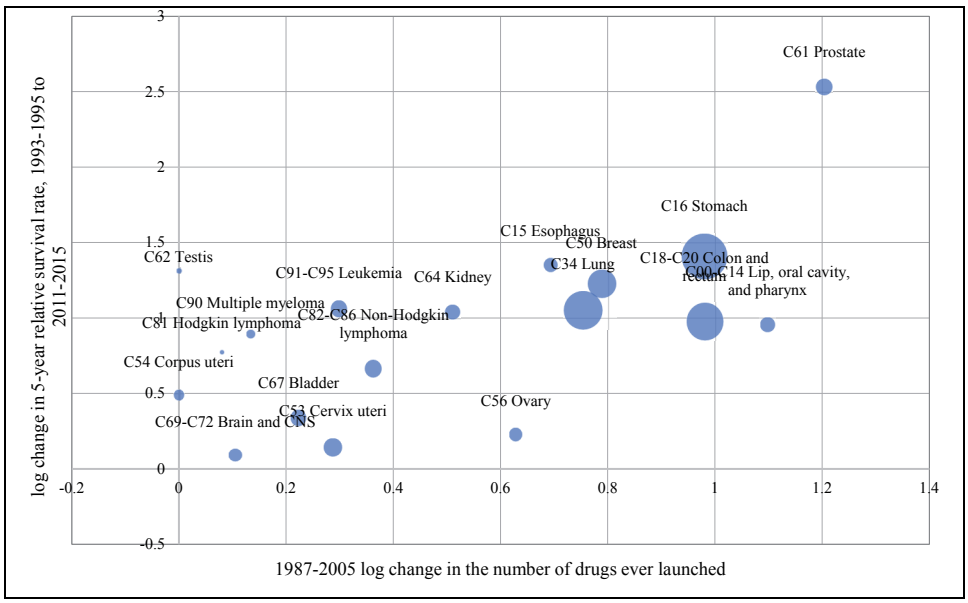
Table 2. Weighted least-squares estimates of the parameter $\beta_k$ from the model of the the long-run change in the log-odds of cancer survival (eq. (7)):
$\ln(SURV_{s,2011}/(1 - SURV_{s,2011})) - \ln(SURV_{s,t0}/(1 - SURV_{s,t0})) = \beta_k [\ln(CUM\_DRUG_{s,2011-k}) - \ln(CUM\_DRUG_{s,t0-k})] + \delta + \varepsilon_s$'

| row | k | $\beta_k$ | Standard Error | t Value | Pr > \|t\| |
|---|---|---|---|---|---|
| | | 1993-1995 to 2011-2015 | | | |
| 1 | 0 | 0.239 | 0.329 | 0.73 | 0.4761 |
| 2 | 1 | 0.314 | 0.317 | 0.99 | 0.3349 |
| 3 | 2 | 0.051 | 0.309 | 0.17 | 0.8697 |
| 4 | 3 | 0.052 | 0.310 | 0.17 | 0.8689 |
| 5 | 4 | **0.905** | **0.267** | **3.38** | **0.0038** |
| 6 | 5 | **0.896** | **0.268** | **3.34** | **0.0041** |
| 7 | 6 | **1.104** | **0.270** | **4.09** | **0.0008** |
| | | 1996-2000 to 2011-2015 | | | |
| 8 | 0 | 0.347 | 0.288 | 1.20 | 0.2439 |
| 9 | 1 | 0.278 | 0.285 | 0.97 | 0.3427 |
| 10 | 2 | 0.264 | 0.280 | 0.95 | 0.3567 |
| 11 | 3 | 0.201 | 0.270 | 0.74 | 0.4674 |
| 12 | 4 | 0.311 | 0.259 | 1.20 | 0.2449 |
| 13 | 5 | 0.211 | 0.270 | 0.78 | 0.4456 |
| 14 | 6 | 0.414 | 0.321 | 1.29 | 0.2136 |
| 15 | 7 | **0.967** | **0.205** | **4.71** | **0.0002** |
| 16 | 8 | **0.952** | **0.204** | **4.66** | **0.0003** |
| 17 | 9 | **1.087** | **0.248** | **4.39** | **0.0005** |

N = 18.
Estimates in bold are statistically significant (p-value < .01).
Observations are weighted by $1/((1/INCIDENCE_{s,1999}) + (1/INCIDENCE_{s,2015}))$, where $INCIDENCE_{st}$ = the age-standardized incidence rate of cancer at site s in year t.

[23] Because data on Korean drug launches before 1988 are not available, it is not possible to estimate models for k > 8.

Figure 4. Correlation across Cancer Sites between the 1987-2005 Log Change in the Number of Drugs ever Launched and the Log Change in the 5-year Relative Survival Rate, 1993-1995 to 2011-2015




Bubble area is proportional to by $1/((1/INCIDENCE_{s,1999}) + (1/INCIDENCE_{s,2015}))$, where $INCIDENCE_{st}$ = the age-standardized incidence rate of cancer at site s in year t.

Between 1993-1995 and 2011-2015, the five-year relative survival rate from all cancers combined increased by 29.5 percentage points, from 41.2% to 70.7%. The estimate of $\beta_6$ in row 4 of Table 2 indicates that 78.5% of this increase in the log-odds of survival was due to new drug launches during 1988-2005.[24] Hence, we estimate that new drugs launched during 1989-2003 increased the five-year relative survival rate from all cancers combined by 23.2 percentage points (= 78.5% * 29.5 percentage points).

[24] The weighted mean of the dependent variable of eq. (7) is 1.086. The intercept of eq. (7) when k = 6 is 0.234. This is an estimate of the 19-year change in the log-odds of cancer survival in the absence of any increase in the number of drugs ever launched 6 years earlier (when $[\ln(CUM\_DRUG_{s,2011-6}) - \ln(CUM\_DRUG_{s,1993-6})] = 0$). Hence the fraction of the increase in the log-odds of survival that was due to new drug launches during 1988-2005 is 78.5% (= 1 – (0.234/1.086)).

Estimates of the parameter $\beta_k$ from the model of the 15-year (1996-2000 to 2011-2015) change in the log-odds of cancer survival (eq. (7)) are presented in rows 8-17 of Table 2. For $k \leq 6$, the estimates are not statistically significant. However, the estimates of $\beta_7$, $\beta_8$ and $\beta_9$ are positive and highly significant. The 15-year change in the log-odds of cancer survival is most strongly related to the log change in the number of drugs ever launched 7 years earlier. Between 1996-2000 and 2011-2015, the five-year relative survival rate from all cancers combined increased by 26.7 percentage points, from 44.0% to 70.7%. The estimate of $\beta_7$ in row 15 of Table 2 indicates that 75.7% of this increase in the log-odds of survival was due to new drug launches during 1990-2004. Hence, we estimate that new drugs launched during 1990-2004 increased the five-year relative survival rate from all cancers combined by 20.2 percentage points (= 75.7% * 26.7 percentage points).

### *3. Hospital Utilization*

Estimates of the parameter $\beta_k$ from the model of the 2014-2017 log change in hospital utilization (eq. (9)) are presented in Table 3. When $k \leq 5$, the estimate is not statistically significant, but when $6 \leq k \leq 9$, the estimates are negative and highly significant. The growth in the number of hospital days is inversely related across diseases to the growth in the number of drugs that had ever been launched 6-9 years earlier. It is most strongly related to the growth in the number of drugs that had ever been launched 7 years earlier. Figure 5 is a bubble plot of the correlation across diseases between the 2007-2010 log change in the number of drugs ever launched and the 2014-2017 log change in the number of hospital days.

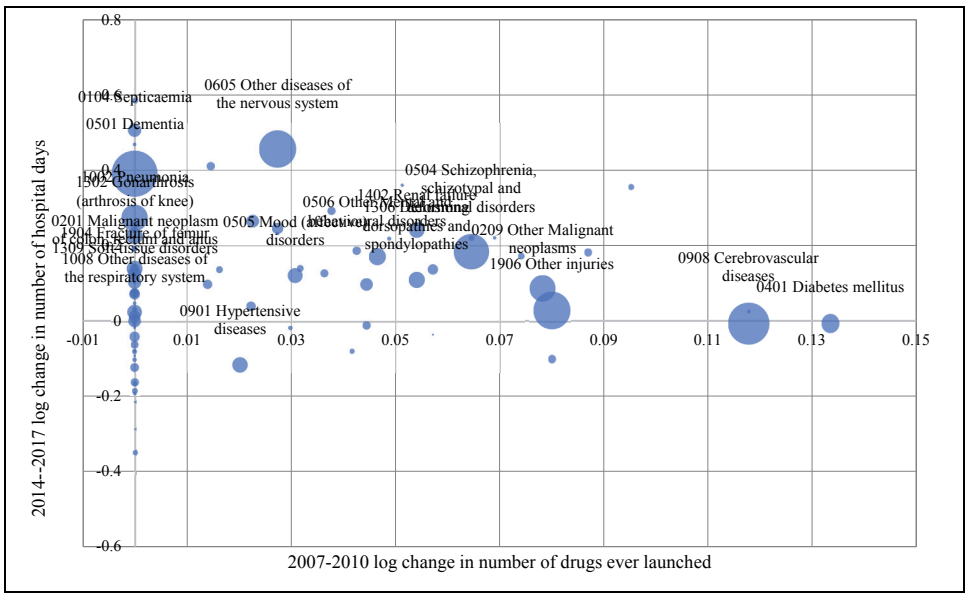
Between 2014 and 2017, the number of hospital discharges increased by 7%, from 8.20 million to 8.74 million, average length of stay increased by 9%, from 17.0 to 18.5 days, and the number of hospital days increased by 16%, from 139.4 million to 161.7 million. Our estimates imply that, if no new drugs had been launched during 2008-2010, the number of hospital days would have increased even more during 2014-2017, and the number of hospital days in 2017 would have been 8.1% higher than it actually was. We estimate that the new drugs that were launched during 2008-2010 reduced the number of hospital days in 2017 by 13.0 million (= 8.1% * 161.7 million).

Table 3. Weighted least-squares estimates of the parameter $\beta_k$ from the model of the 2014-2017 log change in hospital utilization (eq. (9)):
$\Delta\ln(DAYS_d) = \beta_k \Delta\ln(CUM\_DRUG\_k_d) + \delta + \varepsilon_d$‘

| k | $\beta_k$ | Standard Error | t Value | Pr > \|t\| |
|---|---|---|---|---|
| 0 | -1.217 | 1.493 | -0.82 | 0.4172 |
| 1 | 2.055 | 1.212 | 1.70 | 0.0933 |
| 2 | -0.165 | 0.631 | -0.26 | 0.7941 |
| 3 | 0.626 | 0.558 | 1.12 | 0.2651 |
| 4 | -0.717 | 0.441 | -1.63 | 0.1073 |
| 5 | -0.656 | 0.418 | -1.57 | 0.1201 |
| 6 | **-1.004** | **0.279** | **-3.60** | **0.0005** |
| 7 | **-1.725** | **0.330** | **-5.22** | **<.0001** |
| 8 | **-1.702** | **0.337** | **-5.05** | **<.0001** |
| 9 | **-0.952** | **0.323** | **-2.95** | **0.0041** |
| 10 | -0.649 | 0.334 | -1.95 | 0.0547 |

N = 92.
Estimates in bold are statistically significant (p-value < .01).
Observations are weighted by $1/((1/DAYS_{d,2014}) + (1/DAYS_{d,2017}))$, where $DAYS_{dt}$ = the number of days of hospital care provided to patients with diagnosis d in year t.

Figure 5. Relationship across Diseases between 2007-2010 Log Change in Number of Drugs ever Launched and 2014-2017 Log Change in number of Hospital Days




Bubble size is proportional to $1/((1/DAYS_{d,2014}) + (1/DAYS_{d,2017}))$, where $DAYS_{dt}$ = the number of days of hospital care provided to patients with diagnosis d in year t. To improve legibility, only the 20 largest diseases are labeled.

# V. DISCUSSION

We estimated that drugs launched during 2003-2012 (which increased the number of drugs that had ever been launched between the end of 2002 and the end of 2012) increased mean age at death by 1.09 years between 2005 and 2015, and that they reduced the number of life-years lost in 2015 by 300,057. IQVIA data indicate that 2015 expenditure on drugs launched during 2003-2012 was 1.90 billion USD.[25] Hence if the drugs launched during 2003-2012 had had no effect on other medical expenditure in 2015, the cost per life-year gained would not have exceeded 6332 USD (= 1.90 billion USD / 300,057 life-years).[26]

As noted by Bertram et al. (2016), authors writing on behalf of the WHO's *Choosing Interventions that are Cost–Effective* project (WHO-CHOICE) suggested in 2005 that "interventions that avert one disability-adjusted life-year (DALY) for less than average per capita income for a given country or region are considered very cost–effective; interventions that cost less than three times average per capita income per DALY averted are still considered cost–effective."[27] Korea's per capita GDP was 27,105 USD in 2015, so these estimates indicate that, even if we ignore the effect of new drugs on hospital utilization, the drugs launched during 2003-2012 were very cost-effective, overall.

When the effect of new drugs on hospital utilization is accounted for, the evidence indicates that, in the long run, pharmaceutical innovation was cost-saving as well as life-year saving. We estimated that, if no new drugs had been launched during 2008-2010, the number of hospital days in 2017 would have been 8.1% higher than it actually was. It is reasonable to assume that hospital expenditure in 2017 would have

[25] This is 15% of IQVIA's estimate of total pharmaceutical expenditure in 2015: 12.98 billion USD. According to the International Federation of Pharmaceutical Manufacturers & Associations (2017), total sales of prescription drugs in Korea in 2014 was 12.67 billion USD.

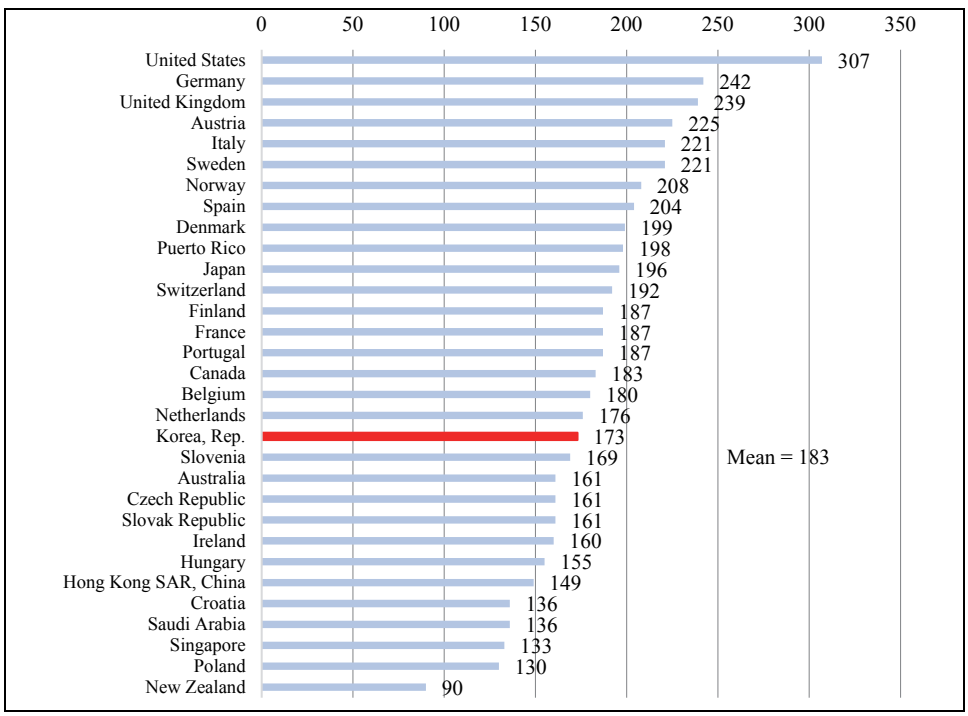
[26] This calculation does not account for the fact that expenditure on other (older) drugs may have been reduced by the use of these drugs.

[27] Other authorities use reasonably similar cost-effectiveness thresholds. The U.K. National Institute for Health and Care Excellence (2019) says that, "in general, interventions with an ICER [Incremental Cost-Effectiveness Ratio] of less than £20,000 per QALY gained are considered to be cost effective." The U.S. Department of Veterans Affairs Health Economics Resource Center (2019) says that "a cost-effectiveness analysis may indicate that Drug A is a good value relative to Drug B, because it has an incremental cost-effectiveness ratio (ICER) of $40,000 per Quality-Adjusted Life Year."

been 8.1% higher than it actually was. 2017 expenditure on inpatient curative and rehabilitative care was 37.4 billion USD, so new drugs launched during 2008-2010 may have reduced 2017 hospital expenditure by 3.0 billion USD (= 8.1% * 37.4 billion USD). This figure is 10.5 times as high as 2017 expenditure on drugs launched during 2008-2010 (287 million USD).[28]

We conclude by comparing the extent of access to new drugs in Korea to the extent of access in other high-income countries. One measure of access is the number of post-2005 new chemical entities (NCEs) sold. As shown in Figure 6, 173 post-2005 NCEs were sold in Korea in 2018. The average number of post-2005 NCEs sold in 31 high-income countries was 183. Korea ranked 19 out of 31 countries.

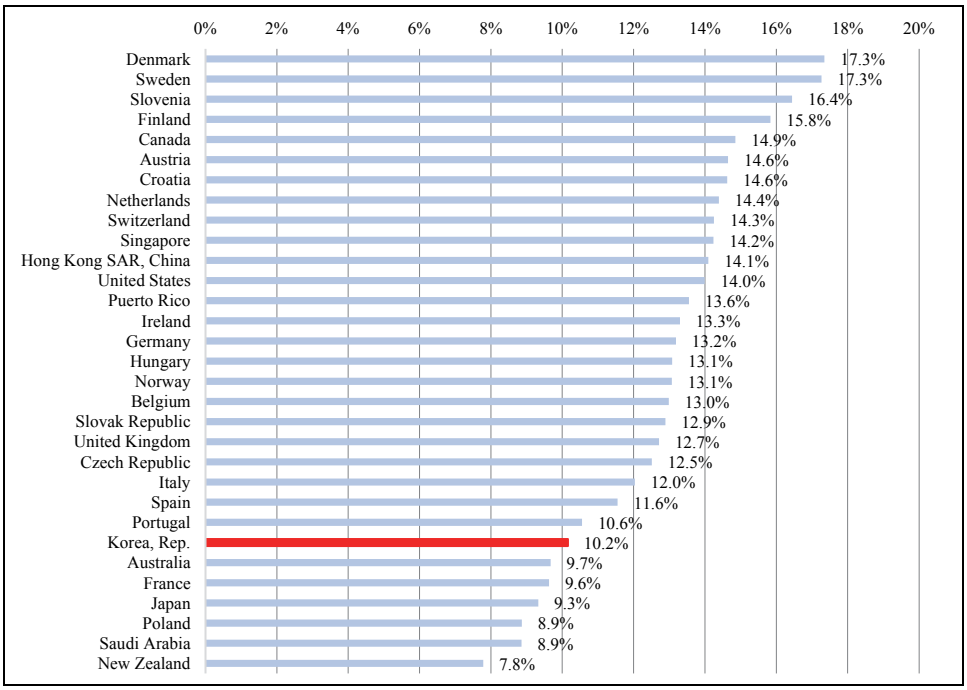
Figure 6. Number of Post-2005 Drugs Sold in 2018: High-income Countries




[28] This estimate is about twice as high as the estimate obtained in a study (Lichtenberg, 2018) based on a different type of 2-way fixed effects research design. That study examined the impact of new drug launches on hospitalization in 2015 for 67 diseases in 15 OECD countries, and found that the reduction in 2015 hospital expenditure that was attributable to post-1981 drug launches was 5.3 times as large as 2015 expenditure on those drugs.

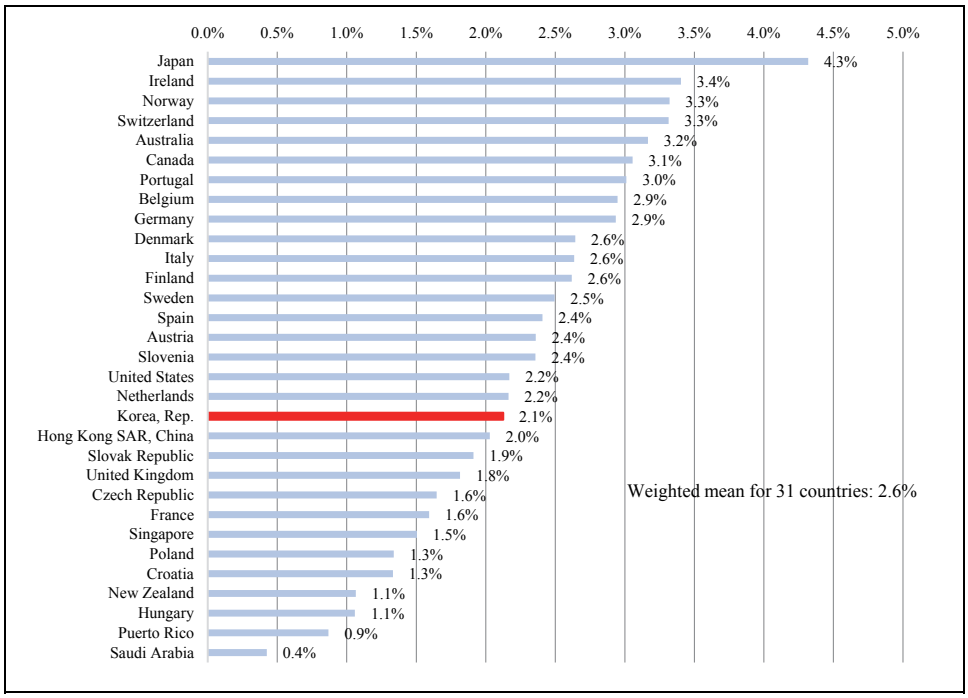
A second measure of access to new drugs is the ratio of the number of post-2005 drugs sold in 2018 to the total number of drugs sold in 2018. The total number of drugs sold in Korea in 2018 (1703) was higher than mean total number of drugs sold in the 31 countries (1455). Consequently, as shown in Figure 7, Korea's rank with respect to this ratio was lower (25 out of 31) than its rank with respect to the number of new (post-2005) drugs sold in 2018.

Figure 7. Number of Post-2005 Drugs Sold in 2018 as % of All Drugs Sold in 2018: High-income Countries




A third, and perhaps most meaningful, measure of access to new drugs is the fraction of standard units (e.g. the fraction of pills) sold that were units of post-2005 drugs. As shown in Figure 8, 2.1% of the standard units sold in Korea in 2018 were units of post-2005 drugs. This figure is lower than the weighted mean figure for 31 high-income countries: 2.6%. Korea ranked 19 out of 31 countries.

Figure 8. Number of Post-2005 Standard Units Sold in 2018 as % of Total Number of Standard Units Sold in 2018: High-income Countries




## VI. SUMMARY AND CONCLUSIONS

We have performed an econometric assessment of the role that pharmaceutical innovation—the introduction and use of new drugs—has played in improving the health of Koreans, by investigating whether diseases for which more new drugs were launched had larger subsequent increases in longevity and smaller subsequent increases in hospitalization. The number of new drug launches varied considerably across diseases.

Drugs launched during 1993-2012 are estimated to have increased mean age at death by 1.71 years between 1995 and 2015. Drugs launched during 2003-2012 are estimated to have increased mean age at death by 1.09 years between 2005 and 2015. This is about one fourth of the actual increase in mean age at death during that period. If drugs launched during 2003-2012 did not affect the total number of deaths or their

distribution across diseases, those drug launches reduced the number of life-years lost in 2015 by 300,057. The average effect on mean age at death of a drug approved during the second half of the 1993-2012 period was 45% larger than the average effect of a drug approved during the entire period; a possible explanation for this is that the average quality of drugs launched during 2003-2012 was higher than the average quality of drugs launched during 1993-2002.

Between 1993-1995 and 2011-2015, the five-year relative survival rate from all cancers combined increased by 29.5 percentage points, from 41.2% to 70.7%. We estimated that new drugs launched during 1989-2003 increased the survival rate by 23.2 percentage points—78.5% of the total increase.

The 2014-2017 growth in the number of hospital days is inversely related across diseases to the growth in the number of drugs that had ever been launched 6-9 years earlier. It is most strongly related to the growth in the number of drugs that had ever been launched 7 years earlier. Our estimates implied that, if no new drugs had been launched during 2008-2010, the number of hospital days in 2017 would have been 8.1% higher than it actually was. We estimated that the new drugs that were launched during 2008-2010 reduced the number of hospital days in 2017 by 13.0 million.

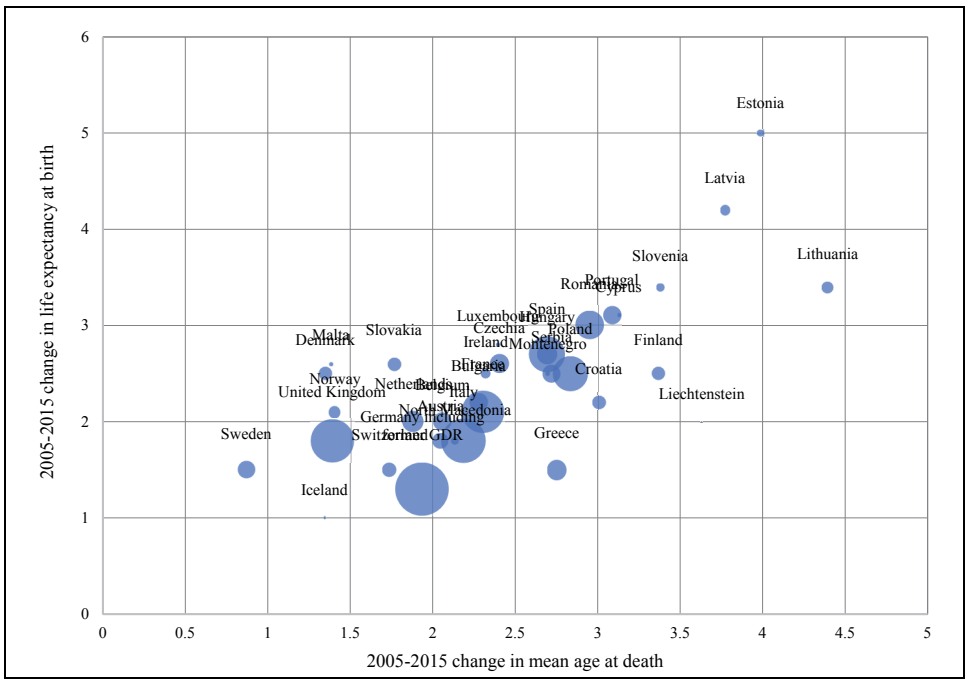
If the drugs launched during 2003-2012 had had no effect on other medical expenditure in 2015, the cost per life-year gained would not have exceeded 6332 USD. These estimates indicate that, even if we ignore the effect of new drugs on hospital utilization, the drugs launched during 2003-2012 were very cost–effective, overall.

When the effect of new drugs on hospital utilization is accounted for, the evidence indicates that, in the long run, pharmaceutical innovation was cost-saving as well as life-year saving. The estimated reduction in 2017 hospital expenditure attributable to new drugs launched during 2008-2010 was 10.5 times as high as 2017 expenditure on those drugs.

Access to new drugs in Korea in 2018 was somewhat lower than access to new drugs in other high-income countries. Korea ranked 19 out of 31 countries with respect to the fraction of standard units (e.g. the fraction of pills) sold that were units of post-2005 drugs.

# APPENDIX

Appendix Figure 1. Correlation across 35 European Countries between 2005-2015 Changes in Mean Age at Death and Life Expectancy at Birth




Bubble size is proportional to the number of deaths in 2015.
Source: Author's calculations based on data from Eurostat database.

Appendix Table 1. Data on Mortality and Number of Drugs ever Launched, by ICD-10 Block

| ICD-10 subchapter | Mean age at death | | Number of deaths | | Number of drugs ever launched | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2005 | 2015 | 2005 | 2015 | 1990 | 1995 | 2000 | 2005 | 2010 | 2015 |
| A00-A09 Intestinal infectious diseases | 65.4 | 80.0 | 94 | 670 | 16 | 17 | 17 | 17 | 17 | 17 |
| A15-A19 Tuberculosis | 67.5 | 75.3 | 2893 | 2208 | 11 | 11 | 12 | 12 | 12 | 14 |
| A20-A28 Certain zoonotic bacterial diseases | 44.2 | 67.5 | 3 | 2 | 9 | 10 | 10 | 10 | 10 | 10 |
| A30-A49 Other bacterial diseases | 71.7 | 78.5 | 1174 | 3104 | 40 | 45 | 49 | 50 | 50 | 50 |
| B00-B09 Viral infections characterized by skin and mucous membrane lesions | 75.8 | 79.2 | 59 | 36 | 10 | 10 | 14 | 15 | 15 | 15 |
| B15-B19 Viral hepatitis | 56.8 | 66.1 | 841 | 667 | 5 | 5 | 7 | 10 | 12 | 13 |
| B20-B24 Human immunodeficiency virus [HIV] disease | 46.4 | 56.2 | 69 | 104 | 0 | 0 | 2 | 2 | 3 | 3 |
| B25-B34 Other viral diseases | 29.6 | 61.3 | 11 | 13 | 1 | 1 | 4 | 4 | 5 | 5 |
| B35-B49 Mycoses | 65.0 | 71.0 | 48 | 86 | 8 | 13 | 16 | 20 | 22 | 23 |
| B50-B64 Protozoal diseases | 38.5 | 68.8 | 3 | 15 | 13 | 13 | 14 | 14 | 14 | 14 |
| C00-C14 Malignant neoplasms of lip, oral cavity and pharynx | 64.4 | 67.0 | 844 | 1170 | 1 | 2 | 3 | 3 | 3 | 3 |
| C15-C26 Malignant neoplasms of digestive organs | 66.3 | 70.3 | 36412 | 39768 | 7 | 9 | 15 | 17 | 23 | 25 |
| C30-C39 Malignant neoplasms of respiratory and intrathoracic organs | 69.4 | 72.5 | 14633 | 18131 | 11 | 14 | 18 | 20 | 23 | 27 |
| C43-C44 Melanoma and other malignant neoplasms of skin | 68.3 | 72.9 | 313 | 500 | 2 | 2 | 3 | 5 | 5 | 9 |
| C45-C49 Malignant neoplasms of mesothelial and soft tissue | 57.6 | 63.4 | 401 | 626 | 11 | 13 | 13 | 13 | 16 | 21 |
| C50-C50 Malignant neoplasm of breast | 55.5 | 59.3 | 1589 | 2354 | 14 | 19 | 28 | 32 | 36 | 38 |
| C51-C58 Malignant neoplasms of female genital organs | 64.1 | 65.5 | 2155 | 2508 | 15 | 18 | 21 | 22 | 23 | 23 |
| C60-C63 Malignant neoplasms of male genital organs | 76.4 | 78.2 | 934 | 1731 | 10 | 13 | 15 | 16 | 16 | 20 |
| C64-C68 Malignant neoplasms of urinary tract | 70.8 | 73.4 | 1720 | 2696 | 11 | 12 | 13 | 14 | 14 | 16 |
| C69-C72 Malignant neoplasms of eye, brain and other parts of central nervous system | 55.1 | 60.0 | 1178 | 1289 | 9 | 9 | 9 | 10 | 10 | 11 |
| C73-C75 Malignant neoplasms of thyroid and other endocrine glands | 65.4 | 71.0 | 422 | 418 | 4 | 4 | 4 | 4 | 6 | 9 |
| C76-C80 Malignant neoplasms of ill-defined, secondary and unspecified sites | 68.8 | 74.6 | 832 | 1035 | 18 | 21 | 29 | 33 | 38 | 44 |
| C81-C96 Malignant neoplasms, stated or presumed to be primary, of lymphoid, haematopoietic and related tissue | 58.0 | 66.5 | 3251 | 4442 | 31 | 34 | 36 | 41 | 49 | 54 |
| D00-D09 In situ neoplasms | 72.5 | 78.8 | 3 | 26 | 10 | 12 | 13 | 14 | 19 | 19 |
| D10-D36 Benign neoplasms | 64.1 | 71.7 | 191 | 255 | 12 | 13 | 16 | 16 | 17 | 19 |

| ICD-10 subchapter | Mean age at death | | Number of deaths | | Number of drugs ever launched | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2005 | 2015 | 2005 | 2015 | 1990 | 1995 | 2000 | 2005 | 2010 | 2015 |
| D37-D48 Neoplasms of uncertain or unknown behaviour | 65.6 | 72.8 | 546 | 1145 | 6 | 6 | 8 | 12 | 19 | 20 |
| D50-D53 Nutritional anaemias | 75.7 | 78.1 | 45 | 44 | 7 | 7 | 7 | 8 | 11 | 11 |
| D55-D59 Haemolytic anaemias | 57.5 | 72.8 | 24 | 17 | 9 | 9 | 9 | 11 | 14 | 15 |
| D60-D64 Aplastic and other anaemias | 58.2 | 75.5 | 208 | 393 | 8 | 8 | 8 | 9 | 12 | 12 |
| D65-D69 Coagulation defects, purpura and other haemorrhagic conditions | 60.6 | 72.4 | 100 | 122 | 16 | 16 | 17 | 19 | 20 | 21 |
| D70-D77 Other diseases of blood and blood-forming organs | 50.5 | 60.8 | 55 | 123 | 1 | 6 | 10 | 13 | 14 | 17 |
| D80-D89 Certain disorders involving the immune mechanism | 24.1 | 64.9 | 10 | 25 | 8 | 8 | 8 | 10 | 10 | 10 |
| E10-E14 Diabetes mellitus | 70.1 | 75.7 | 11776 | 10556 | 6 | 9 | 18 | 25 | 32 | 35 |
| E15-E16 Other disorders of glucose regulation and pancreatic internal secretion | 73.3 | 73.8 | 33 | 67 | 6 | 6 | 9 | 10 | 10 | 10 |
| E20-E35 Disorders of other endocrine glands | 70.1 | 76.7 | 96 | 72 | 21 | 22 | 24 | 24 | 24 | 27 |
| E70-E90 Metabolic disorders | 58.9 | 70.4 | 273 | 675 | 44 | 46 | 54 | 63 | 68 | 76 |
| F00-F09 Organic, including symptomatic, mental disorders | 82.9 | 85.3 | 3205 | 4451 | 0 | 0 | 1 | 1 | 1 | 1 |
| F10-F19 Mental and behavioural disorders due to psychoactive substance use | 54.6 | 57.0 | 1040 | 787 | 15 | 15 | 15 | 16 | 17 | 17 |
| F20-F29 Schizophrenia, schizotypal and delusional disorders | 56.6 | 59.7 | 148 | 65 | 9 | 9 | 12 | 15 | 16 | 16 |
| F30-F39 Mood [affective] disorders | 55.6 | 76.2 | 32 | 19 | 17 | 21 | 30 | 33 | 34 | 35 |
| F40-F48 Neurotic, stress-related and somatoform disorders | 77.9 | 79.5 | 26 | 5 | 19 | 21 | 24 | 25 | 27 | 27 |
| F50-F59 Behavioural syndromes associated with physiological disturbances and physical factors | 56.0 | 70.0 | 10 | 4 | 18 | 20 | 21 | 24 | 25 | 26 |
| F70-F79 Mental retardation | 40.4 | 40.4 | 21 | 14 | 0 | 0 | 1 | 1 | 1 | 1 |
| G00-G09 Inflammatory diseases of the central nervous system | 49.6 | 64.4 | 199 | 219 | 17 | 18 | 19 | 19 | 19 | 20 |
| G10-G14 Systemic atrophies primarily affecting the central nervous system | 60.0 | 64.1 | 252 | 530 | 2 | 3 | 4 | 4 | 4 | 4 |
| G20-G26 Extrapyramidal and movement disorders | 74.9 | 78.9 | 1189 | 3472 | 14 | 15 | 18 | 20 | 20 | 22 |
| G30-G32 Other degenerative diseases of the nervous system | 80.6 | 86.0 | 1193 | 5092 | 1 | 1 | 4 | 5 | 5 | 5 |
| G35-G37 Demyelinating diseases of the central nervous system | 57.2 | 62.2 | 43 | 31 | 6 | 8 | 10 | 12 | 13 | 17 |
| G40-G47 Episodic and paroxysmal disorders | 43.1 | 56.0 | 508 | 452 | 31 | 34 | 39 | 44 | 51 | 55 |
| G50-G59 Nerve, nerve root and plexus disorders | 72.5 | 81.3 | 7 | 4 | 10 | 10 | 12 | 12 | 12 | 12 |

| ICD-10 subchapter | Mean age at death | | Number of deaths | | Number of drugs ever launched | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2005 | 2015 | 2005 | 2015 | 1990 | 1995 | 2000 | 2005 | 2010 | 2015 |
| G70-G73 Diseases of myoneural junction and muscle | 36.7 | 43.7 | 123 | 163 | 12 | 12 | 12 | 12 | 12 | 12 |
| H65-H75 Diseases of middle ear and mastoid | 47.5 | 55.0 | 3 | 2 | 15 | 17 | 17 | 17 | 17 | 17 |
| I10-I15 Hypertensive diseases | 77.5 | 83.8 | 4520 | 5050 | 22 | 34 | 45 | 51 | 51 | 52 |
| I20-I25 Ischaemic heart diseases | 72.4 | 76.2 | 13358 | 14723 | 22 | 30 | 37 | 38 | 39 | 43 |
| I26-I28 Pulmonary heart disease and diseases of pulmonary circulation | 66.0 | 73.1 | 215 | 486 | 7 | 7 | 9 | 11 | 13 | 16 |
| I30-I52 Other forms of heart disease | 69.2 | 76.9 | 5536 | 13114 | 49 | 60 | 66 | 67 | 70 | 72 |
| I60-I69 Cerebrovascular diseases | 73.2 | 76.7 | 31195 | 24453 | 13 | 14 | 16 | 17 | 18 | 19 |
| I70-I79 Diseases of arteries, arterioles and capillaries | 72.5 | 76.5 | 1064 | 1399 | 21 | 23 | 24 | 27 | 29 | 32 |
| I80-I89 Diseases of veins, lymphatic vessels and lymph nodes, not elsewhere classified | 66.6 | 72.5 | 69 | 125 | 26 | 26 | 28 | 28 | 31 | 32 |
| J00-J06 Acute upper respiratory infections | 63.0 | 73.2 | 21 | 22 | 35 | 41 | 44 | 47 | 47 | 47 |
| J09-J18 Influenza and pneumonia | 78.2 | 81.7 | 4136 | 14956 | 27 | 33 | 38 | 45 | 45 | 46 |
| J20-J22 Other acute lower respiratory infections | 52.8 | 79.1 | 21 | 68 | 24 | 29 | 32 | 36 | 36 | 36 |
| J30-J39 Other diseases of upper respiratory tract | 62.4 | 78.1 | 18 | 27 | 33 | 42 | 43 | 47 | 49 | 49 |
| J40-J47 Chronic lower respiratory diseases | 76.9 | 81.2 | 7548 | 7538 | 40 | 46 | 48 | 53 | 56 | 57 |
| J80-J84 Other respiratory diseases principally affecting the interstitium | 70.5 | 75.7 | 746 | 1786 | 7 | 8 | 8 | 8 | 8 | 9 |
| J95-J99 Other diseases of the respiratory system | 73.7 | 81.3 | 481 | 819 | 8 | 9 | 9 | 9 | 9 | 9 |
| K00-K14 Diseases of oral cavity, salivary glands and jaws | 64.5 | 77.5 | 5 | 14 | 12 | 12 | 13 | 13 | 13 | 13 |
| K20-K31 Diseases of oesophagus, stomach and duodenum | 73.9 | 78.1 | 529 | 648 | 12 | 13 | 17 | 18 | 18 | 18 |
| K50-K52 Noninfective enteritis and colitis | 74.9 | 75.0 | 127 | 64 | 9 | 9 | 10 | 11 | 12 | 14 |
| K65-K67 Diseases of peritoneum | 75.2 | 76.3 | 170 | 348 | 5 | 6 | 6 | 6 | 6 | 6 |
| K70-K77 Diseases of liver | 58.0 | 61.3 | 8392 | 6847 | 14 | 14 | 16 | 19 | 22 | 23 |
| K80-K87 Disorders of gallbladder, biliary tract and pancreas | 72.3 | 77.8 | 857 | 1367 | 8 | 8 | 8 | 8 | 8 | 8 |
| K90-K93 Other diseases of the digestive system | 73.2 | 77.0 | 356 | 800 | 16 | 16 | 20 | 21 | 21 | 21 |
| L00-L08 Infections of the skin and subcutaneous tissue | 74.7 | 73.5 | 39 | 83 | 19 | 25 | 26 | 31 | 32 | 32 |
| L10-L14 Bullous disorders | 80.0 | 80.7 | 4 | 37 | 9 | 9 | 9 | 10 | 10 | 10 |
| L20-L30 Dermatitis and eczema | 70.5 | 87.5 | 5 | 1 | 24 | 24 | 26 | 26 | 26 | 27 |
| L50-L54 Urticaria and erythema | 64.5 | 75.9 | 15 | 31 | 8 | 12 | 13 | 15 | 16 | 17 |

| ICD-10 subchapter | Mean age at death | | Number of deaths | | Number of drugs ever launched | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2005 | 2015 | 2005 | 2015 | 1990 | 1995 | 2000 | 2005 | 2010 | 2015 |
| L80-L99 Other disorders of the skin and subcutaneous tissue | 81.8 | 82.8 | 340 | 318 | 29 | 30 | 30 | 31 | 31 | 31 |
| M00-M03 Infectious arthropathies | 76.9 | 77.4 | 31 | 78 | 21 | 23 | 23 | 23 | 23 | 23 |
| M05-M14 Inflammatory polyarthropathies | 73.9 | 76.0 | 274 | 192 | 26 | 28 | 32 | 36 | 37 | 43 |
| M15-M19 Arthrosis | 80.5 | 86.7 | 70 | 55 | 21 | 23 | 26 | 26 | 26 | 27 |
| M30-M36 Systemic connective tissue disorders | 46.9 | 60.0 | 183 | 258 | 12 | 12 | 12 | 15 | 15 | 16 |
| M45-M49 Spondylopathies | 75.6 | 78.9 | 90 | 132 | 10 | 11 | 13 | 15 | 16 | 17 |
| M50-M54 Other dorsopathies | 74.1 | 82.0 | 55 | 22 | 23 | 23 | 23 | 23 | 23 | 23 |
| M70-M79 Other soft tissue disorders | 69.2 | 73.4 | 51 | 88 | 25 | 26 | 26 | 26 | 26 | 26 |
| M80-M85 Disorders of bone density and structure | 81.2 | 85.4 | 639 | 462 | 9 | 9 | 10 | 13 | 15 | 15 |
| M86-M90 Other osteopathies | 71.0 | 76.4 | 65 | 70 | 16 | 18 | 18 | 20 | 20 | 20 |
| N00-N08 Glomerular diseases | 69.4 | 75.6 | 55 | 90 | 11 | 13 | 15 | 15 | 15 | 15 |
| N10-N16 Renal tubulo-interstitial diseases | 77.2 | 80.2 | 86 | 375 | 19 | 22 | 23 | 23 | 23 | 24 |
| N17-N19 Renal failure | 69.3 | 76.0 | 2615 | 5009 | 10 | 11 | 14 | 17 | 20 | 22 |
| N25-N29 Other disorders of kidney and ureter | 75.1 | 79.0 | 25 | 24 | 8 | 8 | 8 | 8 | 8 | 9 |
| N30-N39 Other diseases of urinary system | 80.7 | 82.5 | 189 | 891 | 29 | 36 | 42 | 46 | 48 | 50 |
| N40-N51 Diseases of male genital organs | 78.3 | 81.0 | 58 | 75 | 17 | 24 | 27 | 32 | 33 | 33 |
| N70-N77 Inflammatory diseases of female pelvic organs | 73.0 | 82.3 | 10 | 24 | 14 | 17 | 19 | 21 | 21 | 21 |
| N80-N98 Noninflammatory disorders of female genital tract | 72.5 | 78.0 | 8 | 10 | 32 | 35 | 38 | 40 | 40 | 40 |
| O60-O75 Complications of labour and delivery | 33.4 | 33.3 | 17 | 12 | 10 | 10 | 10 | 11 | 12 | 12 |
| Q20-Q28 Congenital malformations of the circulatory system | 12.8 | 15.1 | 327 | 199 | 1 | 1 | 2 | 2 | 2 | 2 |
| Q60-Q64 Congenital malformations of the urinary system | 50.1 | 56.6 | 33 | 28 | 0 | 0 | 0 | 0 | 0 | 1 |
| Q65-Q79 Congenital malformations and deformations of the musculoskeletal system | 2.0 | 3.2 | 28 | 37 | 1 | 2 | 2 | 2 | 2 | 2 |
| Q80-Q89 Other congenital malformations | 13.6 | 15.1 | 65 | 49 | 4 | 4 | 4 | 4 | 5 | 5 |
| R10-R19 Symptoms and signs involving the digestive system and abdomen | 62.9 | 76.3 | 23 | 26 | 24 | 24 | 28 | 29 | 31 | 31 |
| R40-R46 Symptoms and signs involving cognition, perception, emotional state and behaviour | 80.0 | 78.1 | 10 | 9 | 12 | 12 | 14 | 14 | 15 | 15 |
| R50-R69 General symptoms and signs | 85.9 | 87.2 | 27420 | 15420 | 60 | 63 | 70 | 71 | 72 | 72 |

Appendix Table 2. Data on Cancer Survival and Incidence Rates and Number of Drugs ever Launched, by Cancer Site

| | 5-year relative survival rate | | Age-standardized incidence rate | | Number of drugs ever launched | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Site | 1996-2000 | 2011-2015 | 1999 | 2015 | 1990 | 1995 | 2000 | 2005 | 2010 | 2015 |
| C00-C14 Lip, oral cavity, and pharynx | 46.7% | 64.5% | 3.6 | 4.1 | 1 | 2 | 3 | 3 | 3 | 3 |
| C15 Esophagus | 15.2% | 36.0% | 4.1 | 2.7 | 2 | 3 | 4 | 4 | 5 | 5 |
| C16 Stomach | 46.6% | 75.4% | 43.6 | 33.8 | 4 | 5 | 7 | 8 | 8 | 8 |
| C18-C20 Colon and rectum | 58.0% | 76.3% | 20.4 | 30.4 | 3 | 3 | 7 | 8 | 9 | 11 |
| C22 Liver | 13.2% | 33.6% | 27.9 | 18.2 | 0 | 1 | 2 | 2 | 3 | 3 |
| C23 Gallbladder | 19.7% | 29.1% | 6.5 | 6.6 | 0 | 0 | 0 | 0 | 0 | 0 |
| C25 Pancreas | 7.6% | 10.8% | 5.6 | 7.0 | 1 | 3 | 4 | 4 | 7 | 7 |
| C32 Larynx | 62.3% | 75.5% | 2.3 | 1.3 | 0 | 0 | 0 | 0 | 0 | 0 |
| C34 Lung | 12.7% | 26.7% | 28.5 | 26.4 | 8 | 11 | 15 | 17 | 20 | 24 |
| C50 Breast | 83.2% | 92.3% | 10.7 | 24.8 | 15 | 20 | 29 | 33 | 37 | 39 |
| C53 Cervix uteri | 80.0% | 79.9% | 8.5 | 4.6 | 6 | 6 | 7 | 8 | 8 | 8 |
| C54 Corpus uteri | 81.8% | 87.8% | 1.4 | 3.1 | 2 | 2 | 2 | 2 | 2 | 2 |
| C56 Ovary | 58.9% | 64.1% | 2.7 | 3.2 | 8 | 11 | 14 | 15 | 16 | 16 |
| C61 Prostate | 67.2% | 94.1% | 3.1 | 11.2 | 4 | 7 | 9 | 10 | 10 | 14 |
| C62 Testis | 90.4% | 95.6% | 0.3 | 0.6 | 7 | 7 | 7 | 7 | 7 | 7 |
| C64 Kidney | 66.1% | 82.2% | 3.0 | 5.7 | 4 | 4 | 4 | 5 | 5 | 7 |
| C67 Bladder | 73.1% | 75.8% | 4.6 | 4.3 | 8 | 9 | 10 | 10 | 10 | 10 |
| C69-C72 Brain and CNS | 39.0% | 40.7% | 2.9 | 2.8 | 9 | 9 | 9 | 10 | 10 | 11 |
| C73 Thyroid | 94.9% | 100.3% | 6.3 | 35.2 | 1 | 1 | 1 | 1 | 2 | 3 |
| C81 Hodgkin lymphoma | 71.2% | 82.2% | 0.2 | 0.5 | 12 | 13 | 13 | 13 | 13 | 15 |
| C82-C86 Non-Hodgkin lymphoma | 50.8% | 62.9% | 4.3 | 5.9 | 17 | 18 | 19 | 23 | 25 | 26 |
| C90 Multiple myeloma | 19.8% | 40.9% | 1.0 | 1.6 | 14 | 14 | 15 | 16 | 17 | 18 |
| C91-C95 Leukemia | 33.3% | 51.0% | 4.7 | 5.3 | 24 | 26 | 28 | 31 | 37 | 38 |

Appendix Table 3. Data on Number of Hospital Days and Number of Drugs ever Launched, by Disease

| | Number of hospital days | | Number of drugs ever launched | | | | | |
|---|---|---|---|---|---|---|---|---|
| Cause | 2014 | 2017 | 1992 | 1997 | 2002 | 2007 | 2012 | 2017 |
| 0101 Intestinal infectious diseases except diarrhoea | 219,150 | 312,439 | 10 | 10 | 10 | 10 | 11 | 11 |
| 0102 Diarrhoea and gastroenteritis of presumed infectious origin | 964,994 | 1,037,242 | 4 | 4 | 4 | 4 | 4 | 4 |
| 0103 Tuberculosis | 568,019 | 534,240 | 12 | 13 | 13 | 13 | 13 | 14 |
| 0104 Septicaemia | 1,221,795 | 2,024,374 | 24 | 26 | 27 | 28 | 28 | 28 |
| 0105 Human immunodeficiency virus (HIV) disease | 25,898 | 22,766 | 0 | 4 | 14 | 16 | 20 | 21 |
| 0106 Other infectious and parasitic diseases | 783,655 | 815,668 | 96 | 110 | 120 | 133 | 138 | 138 |
| 0201 Malignant neoplasm of colon, rectum and anus | 1,396,433 | 1,584,697 | 6 | 6 | 10 | 12 | 12 | 14 |
| 0202 Malignant neoplasm of trachea, bronchus and lung | 1,295,765 | 1,428,924 | 13 | 15 | 18 | 22 | 24 | 26 |
| 0203 Malignant neoplasm of skin | 95,774 | 152,839 | 5 | 5 | 8 | 8 | 8 | 11 |
| 0204 Malignant neoplasm of breast | 1,010,542 | 1,292,265 | 16 | 21 | 30 | 36 | 37 | 39 |
| 0205 Malignant neoplasm of uterus | 295,612 | 341,585 | 7 | 7 | 8 | 9 | 9 | 9 |
| 0206 Malignant neoplasm of ovary | 257,118 | 320,517 | 10 | 11 | 14 | 15 | 16 | 16 |
| 0207 Malignant neoplasm of prostate | 254,129 | 322,692 | 5 | 9 | 10 | 11 | 14 | 15 |
| 0208 Malignant neoplasm of bladder | 187,709 | 227,579 | 9 | 9 | 10 | 10 | 10 | 10 |
| 0209 Other Malignant neoplasms | 5,441,436 | 5,927,499 | 54 | 56 | 69 | 86 | 98 | 106 |
| 0210 Carcinoma in situ | 86,969 | 124,628 | 12 | 13 | 15 | 19 | 20 | 20 |
| 0211 Benign neoplasm of colon, rectum and anus | 67,873 | 70,539 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0213 Other Benign neoplasms and neoplasms of uncertain or unknown behaviour | 877,941 | 1,007,287 | 20 | 21 | 28 | 34 | 38 | 39 |
| 0301 Anaemias | 133,429 | 166,042 | 17 | 17 | 18 | 20 | 22 | 22 |
| 0302 Other diseases of the blood and bloodforming organs | 86,702 | 109,383 | 22 | 26 | 33 | 36 | 38 | 40 |
| 0401 Diabetes mellitus | 2,656,886 | 2,638,998 | 7 | 11 | 21 | 28 | 33 | 35 |
| 0402 Other endocrine, nutritional and metabolic diseases | 394,112 | 451,901 | 93 | 99 | 112 | 122 | 131 | 133 |
| 0501 Dementia | 15,004,602 | 22,166,362 | 0 | 0 | 1 | 1 | 1 | 1 |
| 0503 Mental and behavioural disorders due to use of Other psychoactive substance | 24,137 | 24,453 | 3 | 3 | 4 | 5 | 5 | 5 |

| | Number of hospital days | | Number of drugs ever launched | | | | | |
|---|---|---|---|---|---|---|---|---|
| Cause | 2014 | 2017 | 1992 | 1997 | 2002 | 2007 | 2012 | 2017 |
| 0504 Schizophrenia, schizotypal and delusional disorders | 9,723,989 | 11,690,961 | 9 | 10 | 13 | 15 | 16 | 16 |
| 0505 Mood (affective) disorders | 1,803,234 | 2,035,603 | 16 | 22 | 30 | 32 | 33 | 34 |
| 0506 Other Mental and behavioural disorders | 2,296,552 | 2,725,240 | 47 | 51 | 56 | 63 | 67 | 68 |
| 0601 Alzheimer's disease | 200,824 | 360,560 | 1 | 2 | 4 | 5 | 5 | 5 |
| 0602 Multiple sclerosis | 38,565 | 37,248 | 11 | 12 | 15 | 17 | 18 | 21 |
| 0603 Epilepsy | 354,512 | 421,323 | 18 | 21 | 23 | 26 | 29 | 29 |
| 0604 Transient cerebral ischaemic attacks and related syndromes | 141,079 | 121,605 | 7 | 7 | 9 | 9 | 12 | 12 |
| 0605 Other diseases of the nervous system | 9,643,761 | 15,206,795 | 55 | 59 | 69 | 72 | 77 | 79 |
| 0702 Other diseases of the eye and adnexa | 181,598 | 178,520 | 45 | 50 | 60 | 66 | 68 | 69 |
| 0901 Hypertensive diseases | 2,163,044 | 1,928,588 | 29 | 37 | 47 | 49 | 51 | 51 |
| 0902 Angina pectoris | 440,502 | 476,246 | 23 | 24 | 26 | 27 | 30 | 30 |
| 0903 Acute myocardial infarction | 276,266 | 334,723 | 17 | 20 | 23 | 25 | 28 | 28 |
| 0904 Other ischaemic heart disease | 216,018 | 231,671 | 14 | 16 | 19 | 21 | 22 | 22 |
| 0905 Pulmonary heart disease and diseases of Pulmonary circulation | 103,279 | 128,808 | 9 | 9 | 11 | 14 | 18 | 18 |
| 0906 Conduction disorders and cardiac arrhythmias | 400,444 | 480,392 | 18 | 20 | 21 | 22 | 25 | 25 |
| 0907 Heart failure | 539,476 | 612,565 | 17 | 23 | 26 | 27 | 29 | 29 |
| 0908 Cerebrovascular diseases | 14,185,037 | 14,072,000 | 13 | 13 | 16 | 16 | 19 | 19 |
| 0909 Atherosclerosis | 116,635 | 122,407 | 2 | 2 | 3 | 3 | 5 | 5 |
| 0911 Other diseases of the circulatory system | 730,803 | 806,058 | 62 | 64 | 68 | 71 | 73 | 73 |
| 1001 Acute upper respiratory infections and influenza | 954,022 | 916,338 | 35 | 42 | 46 | 48 | 48 | 48 |
| 1002 Pneumonia | 5,222,912 | 6,867,790 | 28 | 33 | 38 | 42 | 43 | 43 |
| 1003 Other acute lower respiratory infections | 724,314 | 641,427 | 22 | 29 | 31 | 34 | 34 | 34 |
| 1005 Other diseases of upper respiratory tract | 254,315 | 235,087 | 38 | 42 | 45 | 47 | 50 | 50 |
| 1006 Chronic obstructive Pulmonary disease and bronchiectasis | 1,140,919 | 1,156,270 | 36 | 42 | 44 | 47 | 48 | 48 |
| 1007 Asthma | 557,302 | 503,913 | 20 | 21 | 22 | 24 | 26 | 26 |
| 1008 Other diseases of the respiratory system | 1,832,517 | 1,878,269 | 17 | 18 | 18 | 18 | 19 | 19 |
| 1103 Diseases of oesophagus | 180,968 | 163,590 | 6 | 7 | 10 | 10 | 10 | 10 |

| Cause | Number of hospital days 2014 | 2017 | Number of drugs ever launched 1992 | 1997 | 2002 | 2007 | 2012 | 2017 |
|---|---|---|---|---|---|---|---|---|
| 1104 Peptic ulcer | 289,656 | 240,729 | 7 | 9 | 13 | 13 | 13 | 13 |
| 1105 Dyspepsia and Other diseases of stomach and duodenum | 173,635 | 146,861 | 5 | 5 | 5 | 5 | 5 | 5 |
| 1109 Crohn's disease and ulcerative colitis | 76,195 | 74,948 | 10 | 10 | 12 | 13 | 14 | 15 |
| 1110 Other noninfective gastroenteritis and colitis | 71,282 | 65,111 | 1 | 1 | 2 | 2 | 2 | 2 |
| 1114 Other diseases of intestine | 262,724 | 284,333 | 19 | 19 | 20 | 20 | 21 | 22 |
| 1116 Other diseases of liver | 616,774 | 610,290 | 15 | 16 | 18 | 22 | 24 | 24 |
| 1119 Diseases of pancreas | 250,487 | 258,434 | 2 | 2 | 2 | 2 | 2 | 2 |
| 1120 Other diseases of the digestive system | 547,122 | 464,275 | 39 | 42 | 45 | 45 | 45 | 45 |
| 1201 Infections of the skin and subcutaneous tissue | 380,962 | 438,235 | 22 | 25 | 28 | 31 | 32 | 32 |
| 1202 Dermatitis, eczema and papulosquamous disorders | 42,993 | 34,666 | 31 | 33 | 36 | 39 | 40 | 41 |
| 1203 Other diseases of the skin and subcutaneous tissue | 506,607 | 763,428 | 53 | 58 | 65 | 68 | 71 | 72 |
| 1301 Coxarthrosis (arthrosis of hip) | 82,337 | 88,717 | 5 | 5 | 5 | 5 | 5 | 5 |
| 1302 Gonarthrosis (arthrosis of knee) | 2,036,467 | 2,550,484 | 8 | 8 | 8 | 8 | 8 | 8 |
| 1304 Other arthropathies | 1,381,700 | 1,383,400 | 50 | 51 | 57 | 60 | 63 | 67 |
| 1305 Systemic connective tissue disorders | 154,224 | 171,107 | 14 | 14 | 16 | 17 | 17 | 18 |
| 1306 Deforming dorsopathies and spondylopathies | 2,112,244 | 2,357,328 | 12 | 13 | 16 | 18 | 19 | 20 |
| 1308 Dorsalgia | 699,000 | 804,097 | 22 | 22 | 22 | 22 | 22 | 22 |
| 1309 Soft tissue disorders | 1,433,152 | 1,589,334 | 27 | 27 | 27 | 27 | 27 | 27 |
| 1310 Other disorders of the musculoskeletal system and connective tissue | 803,879 | 866,283 | 32 | 32 | 35 | 38 | 38 | 38 |
| 1401 Glomerular and renal tubulo-interstitial diseases | 545,815 | 704,823 | 26 | 31 | 32 | 32 | 33 | 33 |
| 1402 Renal failure | 1,830,819 | 2,330,361 | 11 | 14 | 16 | 18 | 21 | 21 |
| 1404 Other diseases of the urinary system | 514,658 | 689,149 | 38 | 44 | 48 | 52 | 56 | 57 |
| 1405 Hyperplasia of prostate | 125,203 | 128,172 | 3 | 5 | 6 | 8 | 9 | 9 |
| 1406 Other diseases of Male genital organs | 63,850 | 73,154 | 17 | 19 | 21 | 23 | 23 | 23 |
| 1407 Disorders of breast | 23,230 | 22,940 | 4 | 4 | 6 | 6 | 6 | 6 |
| 1408 Inflammatory diseases of Female pelvic organs | 99,728 | 82,348 | 15 | 18 | 19 | 20 | 20 | 20 |

| Cause | Number of hospital days | | Number of drugs ever launched | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 2014 | 2017 | 1992 | 1997 | 2002 | 2007 | 2012 | 2017 |
| 1409 Menstrual, menopausal and Other Female genital conditions | 15,652 | 16,579 | 23 | 23 | 25 | 25 | 25 | 25 |
| 1410 Other disorders of the genitourinary system | 193,187 | 192,074 | 17 | 19 | 21 | 22 | 22 | 22 |
| 1501 Medical abortion | 936 | 624 | 2 | 2 | 3 | 3 | 3 | 3 |
| 1502 Other pregnancy with abortive outcome | 35,814 | 26,830 | 3 | 3 | 4 | 4 | 4 | 4 |
| 1504 Complications of pregnancy predominantly during labour and delivery | 260,152 | 295,620 | 11 | 11 | 11 | 13 | 13 | 13 |
| 1505 Single spontaneous delivery | 262,745 | 185,002 | 0 | 0 | 0 | 1 | 1 | 1 |
| 1601 Disorders related to short gestation and low birthweight | 234,491 | 216,544 | 4 | 4 | 4 | 4 | 4 | 4 |
| 1804 Other symptoms, signs and abnormal clinical and laboratory findings | 1,242,236 | 1,619,036 | 107 | 116 | 125 | 131 | 134 | 135 |
| 1901 Intracranial injury | 2,089,808 | 2,238,670 | 4 | 4 | 4 | 4 | 5 | 5 |
| 1904 Fracture of femur | 2,016,902 | 2,318,057 | 0 | 0 | 2 | 3 | 3 | 3 |
| 1906 Other injuries | 11,317,131 | 11,642,486 | 12 | 12 | 12 | 12 | 13 | 13 |
| 1908 Poisonings by drugs, medicaments, and biological substances and toxic effects | 101,404 | 93,922 | 17 | 17 | 17 | 18 | 18 | 18 |
| 1909 Complications of Surgical and medical care, n.e.c. | 294,865 | 336,941 | 25 | 28 | 36 | 41 | 41 | 41 |
| 1911 Other and unspecified effects of external causes | 41,427 | 47,997 | 13 | 14 | 15 | 15 | 15 | 15 |
| 2102 Contraceptive management | 131 | 135 | 3 | 3 | 4 | 4 | 5 | 5 |
| 2105 Other factors influencing Health status and contact with Health services | 569,158 | 686,042 | 19 | 20 | 22 | 23 | 25 | 25 |

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