UDC 616-036.22:364.444:657.4
DOI 10.54229/2226-2008-2021-5-9

Rodney P Jones

THE EPIDEMIOLOGY OF HEALTH AND SOCIAL CARE COST AND CAPACITY SHOCKS

Department of Population Analysis, Healthcare Analysis & Forecasting, Oxfordshire, UK
E-mail: hcaf_rod@yahoo.co.uk

УДК 616-036. 22:364. 444:657. 4
DOI 10.54229/2226-2008-2021-5-9
Родні П. Джонс
ЕПІДЕМІОЛОГІЯ ВИТРАТ НА ЗДОРОВ'Я ТА СОЦІАЛЬНУ ДОПОМОГУ І РЕСУРСНІ ПРОБЛЕМИ
Департамент аналізу населення, аналізу і прогнозування охорони здоров'я, Оксфордшир, Велика Британія

Фінансовий та ресурсний тиск, з яким стикаються лікарні та організації соціальної допомоги, є набагато вищим, ніж уявлялось.

Кінець життя — це час інтенсивного використання ургентної та соціальної допомоги. Абсолютна смертність (та її щорічні варіації) вчиняють великого тиску на ресурсні й фінансові можливості зазначених організацій. Підвищена зважена щільність населення пов'язана з більшою річною мінливістю показників смертності, госпіталізації й відсутності з причини захворювання, що, вочевидь, працює через безліч (місцевих) спалахів інфекційних захворювань, викликаних понад 2000 відомими видами патогенів людини. Формули фінансування, що використовуються для розподілу грошей місцевим органам охорони здоров'я та організаціям соціальної допомоги з усього світу, звичайно не містять жодного визначення ролі абсолютної кількості смертей у витратах, зроблених такими організаціями. Урядам усього світу потрібний набагато більш тонкий підхід для вирівнювання вищезазначених тисків, які не можуть бути контрольовані організаціями, що займаються наданням медичної та соціальної допомоги.

Ключові слова: кількість лікарняних ліжок, закінчення життя, демографічне передбачення, охорона здоров'я та соціальна охорона, ціна.

UDC 616-036.22:364.444:657.4
DOI 10.54229/2226-2008-2021-5-9
Rodney P Jones
THE EPIDEMIOLOGY OF HEALTH AND SOCIAL CARE COST AND CAPACITY SHOCKS
Department of Population Analysis, Healthcare Analysis & Forecasting, Oxfordshire, UK

The aim. The financial and capacity pressures experienced by hospitals and social care organisations are far higher than has been realized. End-of-life is a time of high utilization of acute and social care.

Materials and methods. The absolute number of deaths (and its year-to-year variation) then acts to drive the marginal pressures in both capacity and costs for these organisations. Higher weighted population density is associated with higher year-to-year volatility in deaths, hospital admissions and sickness absence, which seems to work via a multitude of (local) infectious outbreaks from the >2,000 known species of human pathogens.

Results. The funding formulae used to distribute money to area health boards and social care organisations around the world do not generally contain any recognition for the role of the absolute number of deaths in the costs incurred by such organisations. A far more nuanced approach is required by governments around the world to equalising these pressures which are beyond the control of the organisations involved in delivering health and social care.

Key words: hospital bed numbers, end-of-life, demographic forecasting, health and social care, costs.

Introduction

The COVID-19 epidemic has elegantly illustrated how infectious outbreaks can create huge capacity and cost shocks for the health and social care system. As of July 2021, there have been >190 million cases and >4. 2 million reported deaths [1]. However, in addition to coronavirus there are >2,000 known species of human pathogens [2-4], and of the viruses alone it has been estimated that between 89 to 265 new species remain to be identified [5].

A fascinating study using next generation PCR for microbial DNA sampled the surfaces of the transport networks in world cities and identified 1,302 new species of bacteria and 10,928 previously uncharacterised viruses [6]. While only a proportion of these will be actual or opportunistic human pathogens this study illustrates the vast potential for humans to acquire infections of unknown aetiology.

Financial and Capacity Risk is Extremely High

Over the past 30 years this author has been investigating the reasons why health and social care costs show such extreme volatility (see Appendix), where volatility = risk. The implications of this large body of research have been largely ignored because it seemingly contradicts the expectation by policy makers that the 'push and pull' of policy has a direct influence on costs. Failure to contain costs is therefore incorrectly perceived as a 'failure' of management competence [7]. It is far easier to blame managers than accept that the assumptions behind policy are flawed.

My own personal experience showed that cost pressures in the English NHS always increased during unexplained periods of higher deaths [8]. This also contradicts accepted wisdom in that costs are supposed to be driven by population demography, otherwise called the ageing population. However, the key breakthrough in understanding the apparent paradox came via a link with nearness to death (NTD).

Recent Advances

To untangle the multiple issues behind capacity and financial risk a recent 4-Part series has highlighted advances in thinking in this area. This series has particularly investigated the potential role of local infectious outbreaks on the cost and capacity pressures experienced in individual hospitals or local authorities in different parts of the world [9-12]. A breakthrough in thinking emerged when it is realized that NTD is just the tip of the mortality/morbidity pyramid. A summary of the 4-Parts will now be given which will then be followed by additional material illustrating these issues.

Materials and Methods

In Part 1 of the series, the international spread of COVID-19 was used to illustrate the role of spatiotemporal granularity in all infectious outbreaks, i. e., immediately adjacent areas can be subject to vastly different cost and capacity pressures. Even in January of 2021 there were some counties in the USA where there had been no reported COVID-19 deaths since March 2020. Hospital capacity pressures around the world were illustrated as the ratio of COVID-19 deaths per 1,000 hospital beds available in each country before the pandemic. An important role for population density was also illustrated. High population density equates to more opportunity for person-to-person spread of pathogens. High population density seems associated with higher year-to-year volatility in deaths and winter mortality, i. e., cost and capacity pressures and their instability are exaggerated by population density.

Part 2 discusses how population density is associated with air pollution which is a source of inflammation. Inflammation enhances infection rates and the severity of ensuing illness. The difference between the male and female response to inflammation (induced by obesity, pollution, cold and infection) then appears to lie behind variation in the gender ratio for deaths and hospital admissions in different locations.

Part 3 then discusses how interaction between pathogens crafts the winter pressures in each location. No pathogen can operate in splendid isolation, and this includes influenza. Pathogens interact in complex ways either inhibiting or enhancing infection between pathogens. Preliminary evidence suggests that COVID-19 is highly competitive against other pathogens.

Finally, part 4 investigates the size (as number of deaths) required for an insurance company, area health board or a social care district to achieve the minimum level of year-to-year volatility. The evidence shows that over 20,000 to 25,000 deaths per annum are required — which is greater than the size of most area health boards in many countries. This creates unequal financial pressures which can be equalized by adjusting annual funding for the difference between actual and forecast deaths — along with differences in costs due to cause of death. This part also investigated the role of a count of deaths as a dual proxy for the NTD effect and wider morbidity.

Results

Nearness to Death (NTD)

It has been known for over 40 years that the health and social care costs of individuals escalate in the last years of life [13], and that acute costs especially escalate in the last year of life. In England, in the last three months of life nursing home and residential care costs an average of ≤1,000 per death, district nursing costs around J280 per death, hospice care around J550 per death, and hospital costs were around J4,500 per death [14]. Somewhere over an average of J6,300 per death in just the last three months of life.

Hence, the absolute number of deaths serves as a proxy for both the cost and capacity pressures in health and social care. Figure 1 shows a rolling 12-month total of deaths in England between 1949 to 2020. The spike in the winter of 1950/51 was from two months of freezing weather which was the coldest in 200 years in the UK and effected much of the northern hemisphere [15; 16]. Between then and 2020 is a complex overall trend determined by past births/deaths and changes in life expectancy. However, the observed trend is overlaid with a complex series of sub-trends. It is clear from Figure 1 that end-of-life shows a series of cost and capacity shocks which include COVID-19.

In a rolling 12-month total a 'spike' in deaths due to influenza generates a 'table-top' shaped feature. As can be seen before 1989/90 such 'table-top' features were relatively common but are less so since then. More complex shapes indicate that other mechanisms are becoming more common. For example, note the period of unexplained higher deaths which occurred from January 2015 through to January 2019. In this respect it has been proposed that influenza vaccination has inadvertently acted to alter the balance between human pathogens [17].

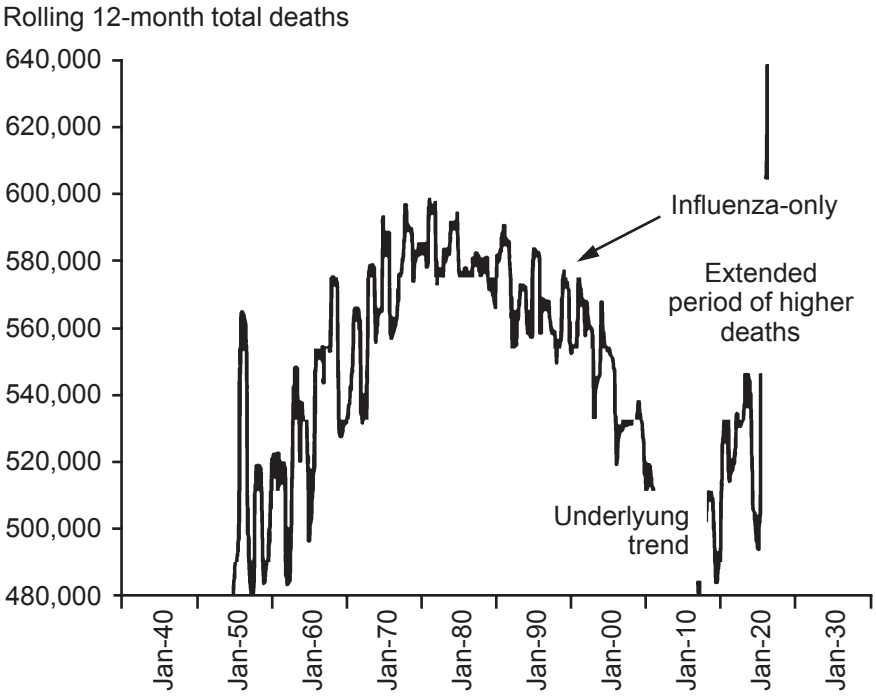

Fig. 1. Rolling 12-month total of deaths in England and Wales, 1949 to 2021

In countries away from the equator most deaths occur in winter, and this can be encapsulated in an excess winter mortality (EWM) calculation which compares the difference in average deaths in the four 'winter' months versus the eight 'non-winter' months [18]. This can also be shown as a rolling calculation and such a calculation is given in Figure 2 for Singapore (just above the equator) and Ireland (almost equidistant between the equator and North pole). As

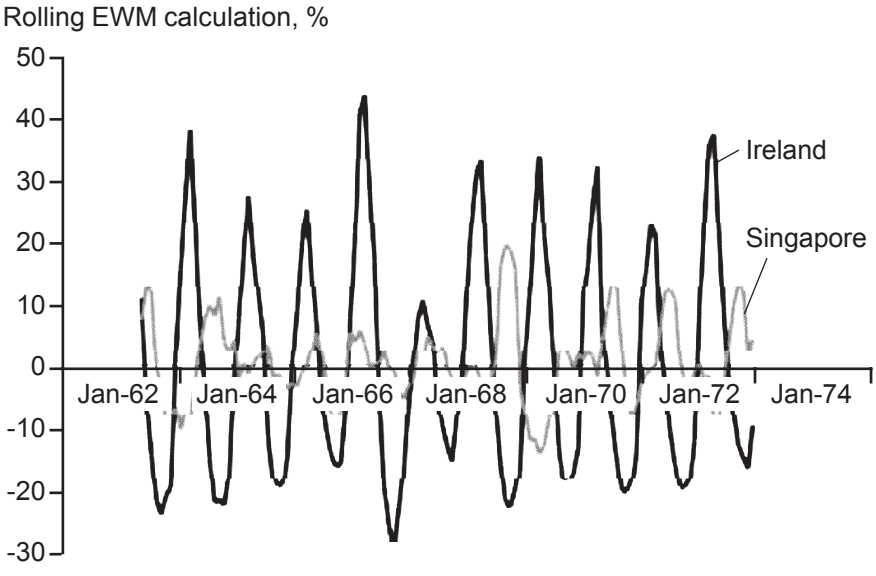

Fig. 2. Rolling excess winter mortality (EWM) calculation for Ireland (53 °N) and Singapore (1 °N), 1962 to 1972

can be seen Ireland experienced large winter excess mortality due to a mix of cold and winter infections while Singapore, which has little seasonal temperature variation, experiences a more muted pattern which is consistent with two influenza seasons per year (reflecting northern and southern hemisphere influences). The 1968 peak in Singapore was the Hong Flu pandemic which originated close to Singapore, and then struck the more northern countries later in the winter of 1968/69.

The point is that end-of-life related capacity and cost pressures will be more winter focussed away from the equator and less so near the equator where the rainy season seems to substitute for winter. Infectious outbreaks such as influenza are part of these pressures.

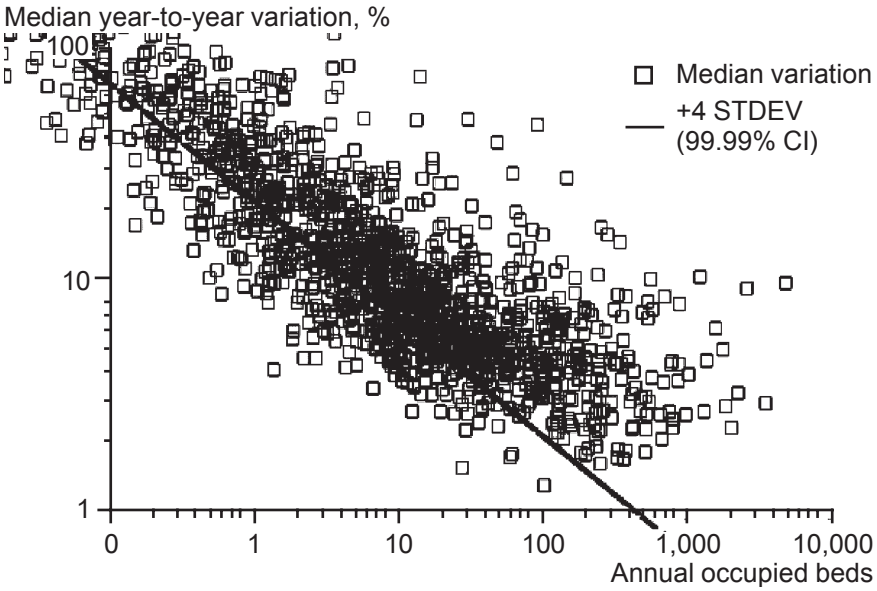

Fig. 3. The median value of the year-to-year variation (absolute value) in occupied beds for 1,600 ICD-10 diagnoses (3-digit) in England, 1999/00 to 2019/20 [20]

Deaths also Serves as a Far Wider Proxy for Morbidity

Any agent capable of causing death in some people will also hospitalize many others who go on to recover. The number of deaths then becomes a proxy for wider morbidity. In England it has been estimated that in some years up to half of all occupied medical bed days in hospital may be influenced by this relationship between death and wider morbidity [12]. This seems to explain why over the past 20 years the ratio of medical occupied bed days per death in England has remained remarkably constant despite large changes in the number of deaths (as per Figure 1) and changing trends in morbidity [19].

Figure 3 illustrates the power of this association between deaths and wider morbidity by looking at the year-to-year difference in occupied beds for 1,600 ICD-10 diagnoses at 3-digit level, i. e., A00 = cholera, T68 = hypothermia, Z03 = medical evaluation for suspected diseases, etc. This analysis covers both elective and emergency admissions for the whole of England for the years 1999/00 to 2019/20. Data is for the effective midday occupancy, hence midnight occupancy plus 3% to convert midnight to midday, plus all same day stay admissions at an assumed 8 hour stay. The median value of the year-to-year variation was chosen to avoid the undue effect of outlying values due to changes in the ICD-10 definitions over time. For diagnoses where there have been gross changes in definitions, outlying values have been removed before calculating the median. As can be seen all diagnoses associated with high bed occupancy, i. e., greater than 200 occupied beds per annum, show remarkably high year-to-year variation above the Poisson-based 100% confidence interval. It is these high bed occupancy/high volatility diagnoses which drive the overall volatility in bed occupancy and related costs. Some 75% of diagnoses lie higher than the 99.99% confidence interval, i. e., the variation is systematic and cannot be due to chance. Implied in Figure 3 is the fact that volatility increases as the organisation size becomes smaller.

During a period of rising deaths in England it was observed that some diagnoses increased while others decreased [21,22]. The sources of the volatility are clearly more complex than realized.

Volatility and Risk are Location Specific

Lastly Figure 4 demonstrates the principle that while the volatility in deaths is high (as per Figure 1) it is also location specific. Figure 4 illustrates how a rolling 12-month total of deaths differs from the previous 12-month total. Hence in Figure 4, Dec-02 is the difference between 12-month total deaths at Dec-02 compared to Dec-01, move forward 1 month and repeat. Note that the UK median is itself volatile ranging from — 6% to +10% in the era before COVID-19 (as expected from Figure 1). Hence in some years, this year's costs are low-

er than last year while in other years they are substantially higher. Also shown is the interquartile range (IQR).

As the IQR gets larger the range of values between LGAs becomes more disparate. The minimum IQR occurred in July 2019 while the maximum occurred in March 2007. COVID-19 displays high spatiotemporal granularity [9], hence the high IQR from April 2020 onward. Recall that the IQR only covers the middle 50% of LGAs which implies only LGA with >1,300 deaths per annum (which is more than many of the worlds smaller countries). Such is the extent of this disparity that in most years the difference in costs compared to last year (using deaths as a proxy) will simultaneously range from lower in some areas to higher in others. In the past the managers in areas with lower costs have been praised while those in higher areas have been castigated for perceived 'failure'.

Figure 4 therefore illustrates that the national average cost and capacity 'pressure' is not equally felt in all areas, and that under certain circumstances (as in COVID-19) the range in cost and capacity pressures between areas is extreme.

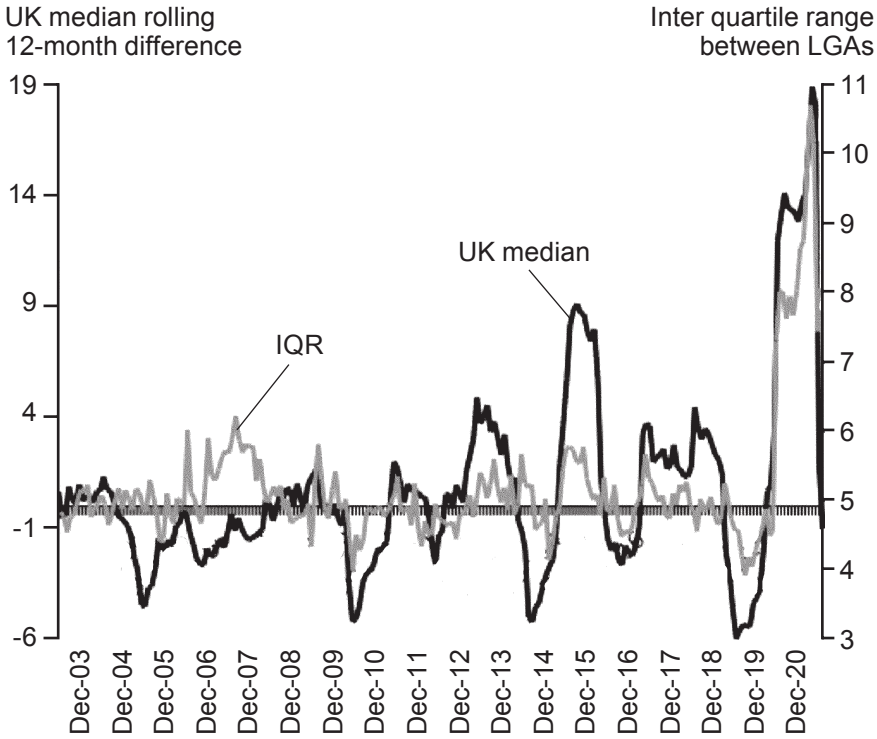

Fig. 4. The UK median and inter quartile range (IQR) for the rolling 12-month difference in 12-month total deaths for 510 local government areas (LGAs), 2001 to 2021 [21]

Conclusions

The outcome of financial risk is a postcode (or location-specific) lottery in which some health and social care organisations are unable to afford the same level of services offered elsewhere. In the past this has been perceived to be directly due to a lack of management competence and hence the need for a national competence framework [7]. However, this series clearly demonstrates that while it is desirable to have competent managers, the financial pressures primarily arise from factors outside of their ability to control.

This series also illustrates the truth that capacity and financial risk in health and social care is unacceptably high and that governments need to directly intervene to equalize financial pressures which are beyond the control of the smaller health and social care organisations.

Sources of Funding: None.

Conflicts of Interest: None to declare.

Ключові слова: кількість лікарняних ліжок, закінчення життя, демографічне передбачення, охорона здоров'я та соціальна охорона, ціна.

REFERENCES

1. Worldometer. COVID-19 coronavirus pandemic. COVID Live Update: 189,383,984 Cases and 4,077,622 Deaths from the Coronavirus — Worldometer (worldometers. info)

2. Schlaberg R, Simmon K, Fisher M. A systematic approach for discovering novel, clinically relevant bacteria. *Emerg Infect Dis*. 2012;18(3):422-430. DOI:10. 3201/eid1803. 111481

3. Sкkowska A, Gospodarek-Komkowska E. New species of bacteria in human infections. *Advancements of Microbiology — POSTKPY MIKROBIOLOGII* 2019;58(1):29-34. DOI:10. 21307/PM-2019. 58. 1. 029

4. Woolhouse ME, Gowtage-Sequeria S. Host range and emerging and reemerging pathogens. *Emerg Infect Dis* 2005;11(12):1842-7. DOI:10. 3201/eid1112. 050997.

5. Woolhouse M, Scott F, Hudson Z, et al. Human viruses:discovery and emergence. *Philos Trans R Soc Lond B Biol Sci* 2012;367(1604):2864-2871. DOI:10.1098/rstb.2011.0354

6. Danko D, Bezdan D, Afshin E. A global metagenomic map of urban microbiomes and antimicrobial resistance. *Cell* 2021;184(13):3376-3393.

7. Russell J, Greenhalgh T, Lewis H, et al. Addressing the 'postcode lottery' in local resource allocation decisions:a framework for clinical commissioning groups. *J R Soc Med* 2013; 106:120-123.

8. Jones R. Could cytomegalovirus be causing widespread outbreaks of chronic poor health? In Hypotheses in Clinical Medicine 2013;Chapter 4, pp 37-79, Eds M. Shoja, et al. New York: Nova Science Publishers Inc. Available

from:(5) (PDF) Could cytomegalovirus be causing widespread outbreaks of chronic poor health? (researchgate.net)

9. Jones R. Multidisciplinary insights into health care financial risk and hospital surge capacity, Part 1:Nearness to death, infectious outbreaks, and Covid-19. *J Health Care Finance.* 2021;47(3):Vol. 47, No. 3, Winter 2021 (healthfinancejournal.com)

10. Jones R. Multidisciplinary insights into health care financial risk and hospital surge capacity, Part 2: High population density is associated with enhanced year-to-year volatility in many aspects of poor health including health care worker sickness absence. *J Health Care Finance.* 2021;47(3): Vol. 47, No. 3, Winter 2021 (healthfinancejournal.com)

11. Jones R Multidisciplinary insights into health care financial risk and hospital surge capacity, Part 3:Outbreaks of a new type or kind of disease create unique risk patterns and confounds traditional trend analysis. *J Health Care Finance.* 2021;47(3): Vol. 47, No. 3, Winter 2021 (healthfinancejournal.com)

12. Jones R. Multidisciplinary insights into health care financial risk and hospital surge capacity, Part 4:What size does a health insurer or health authority need to be to minimise risk? *J Health Care Finance.* 2021;47(3): Vol. 47, No. 3, Winter 2021 (healthfinancejournal.com)

13. Jones R, Kellet J. The way healthcare is funded is wrong:it should be linked to deaths as well as age, gender and social deprivation. *Acute Medicine* 2018;17(4)**:**189-193. See https://acutemedjournal.co.uk/original-articles/the-way-healthcare-is-funded-is-wrong-it-should-be-linked-to-deaths-as-well-as-age-gender-and-social-deprivation/

14. Georghiou T, Bardsley M. Exploring the cost of care at the end of life. Nuffield Trust, September 2014. Headings Arial 14pt / 17 (nuffieldtrust.org.uk)

15. Klein W. The Weather and Circulation of the Winter of 1950-51, Weatherwise, 1951;4(2), 38-46. DOI: 10.1080/00431672.1951.9932147

16. Kalvová, J., Rein, F. The problem of temperature trends and winter seasons 1950-1977 at the observatories in Prague-Klementinum and at Milešovka. *Stud Geophys Geod* 1980; 24, 201-207. https://doi.org/10.1007/BF01634414

17. Jones R, Ponomarenko A. The influenza vaccination paradox:why has increased vaccination seemingly increased excess winter mortality (EWM)? IJERPH (submitted)

18. Jones R. Excess winter mortality (EWM) as a dynamic forensic tool: Where, when, which conditions, gender, ethnicity, and age. *Int J Environ Res Public Health* 2021;18(4);2161. https://doi.org/10.3390/ijerph18042161

19. Jones R. Were the hospital bed reductions proposed by English Clinical Commissioning Groups (CCGs) in the Sustainability and Transformation Plans (STPs) achievable? Insights from a new model to compare international bed numbers. *Intl J Health Planning and Management* 2021;36(2):459-481**.** https://doi.org/10.1002/hpm.3094

20. NHS Digital. Hospital admitted patient care activity. Hospital Admitted Patient Care Activity — NHS Digital (accessed 16 July 2021)

21. Jones R. A reduction in acute thrombotic admissions during a period of unexplained increased deaths and medical admissions in the UK. *Eur J Internal Medicine* 2017;46:e31-e33. http://dx.doi.org/10.1016/j.ejim.2017.09.007

22. Jones R. Admissions for certain conditions show explosive growth in England following a sudden and unexpected increase in deaths. *Eur J Internal Medicine.* 2018;54:e33-e35. DOI: https://doi.org/10.1016/j.ejim.2018.03.005

23. Monthly data on deaths by area of residence from the respective websites of Office for National Statistics, National Records of Scotland, and Northern Ireland Research Agency.

Submitted 05.10.2021
Put into print 11.10.2021
E-mail: hcaf_rod@yahoo.co.uk

УДК 614.876:616-055.6:577.122:616-092.4
DOI 10.54229/2226-2008-2021-5-10

Г. Ф. Степанов, Н. Є. Ясиненко, В. Л. Давиденко, А. Г. Васильєва

БІОХІМІЯ КОРОТКОЧАСНОЇ ТА ДОВГОТРИВАЛОЇ ПАМ'ЯТІ

Одеський національний медичний університет МОЗ України, Одеса, Україна

УДК 614.876:616-055.6:577.122:616-092.4
DOI 10.54229/2226-2008-2021-5-10
Г. Ф. Степанов, Н. Є. Ясиненко, В. Л. Давиденко, А. Г. Васильєва
БІОХІМІЯ КОРОТКОЧАСНОЇ ТА ДОВГОТРИВАЛОЇ ПАМ'ЯТІ
Одеський національний медичний університет МОЗ України, Одеса, Україна

Пам'ять забезпечується змінами синапсів у нейронних ланцюгах: короткочасна пам'ять — функціональними змінами в окремому сенсорному нейроні й окремому мотонейроні, довготривала пам'ять — структурними змінами (відростання нових синапсів).

При формуванні короткочасної пам'яті в синапсах використовується цАМФ, протеїнкіназа А, які діють усередині клітини і передають сигнал, що викликає виділення великої кількості нейромедіатора глутамату.