LOADBALANCER

WHITE PAPER

A single technology for a Quadruple Aim

Discover how load balancing technology can be used in hospitals to enhance the patient experience, improve population health, reduce costs and support healthcare professionals.

Executive Summary

Even before the emergence of COVID-19, hospitals and other medical facilities in the USA were under strain. Many patients already faced long waiting times, population health was declining, healthcare staff were overwhelmed and costs were escalating. The challenges faced then are the same challenges faced today – yet they have magnified in size exponentially amid the pressures of responding to a global pandemic.

While many countries across the developed world face these same healthcare challenges, urgent action is needed to address them in the USA in particular. A report published in 2017 by the Commonwealth Fund placed the USA in last place for healthcare performance, when compared to the healthcare systems of other high-income countries including Australia, Canada, France, Germany, New Zealand and the UK. Significantly, as well as coming bottom overall in this study, the USA ranked last of 11 developed countries for healthcare outcomes[1].

There are many different approaches that healthcare providers can take to deliver the seismic change that the healthcare industry needs. One improvement framework that is widely recognized, accepted and adopted around the world, and in the USA in particular, is the Quadruple Aim. As its name suggests, it focuses attention on four clear priorities:

1. Enhancing the patient experience
2. Improving population health
3. Supporting healthcare professionals
4. Reducing healthcare costs.

Technology has the potential to help hospitals and other healthcare providers achieve the Quadruple Aim. Huge advancements in medical technology are being announced all the time - from digital pathology solutions that use artificial intelligence to detect abnormalities, to 3D printed hearts for transplant patients. These are the new technologies that grab the headlines,

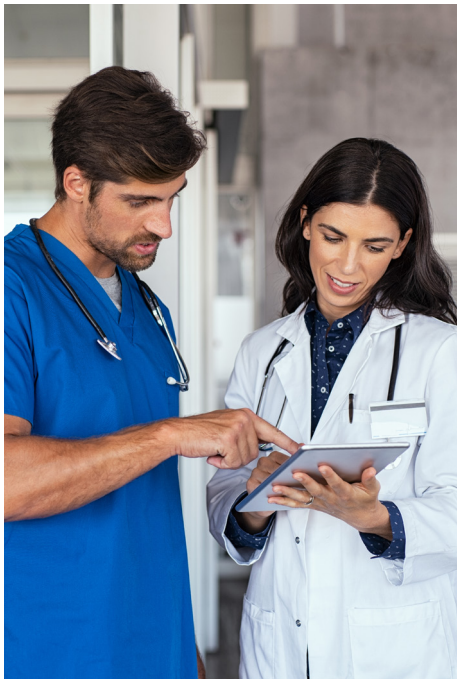
1 Mirror, Mirror 2017: International Comparison Reflects Flaws and Opportunities for Better U.S. Health Care [Internet]. 2017 [cited 2022 Jan 27]. Available from: https://www.commonwealthfund.org/publications/fund-reports/2017/jul/mirror-mirror-2017-international-comparison-reflects-flaws-and

but in IT departments of hospitals and medical centers, there exists already a technology capable of playing a small but important role in helping organizations rise to these challenges: load balancing.

Most hospitals and healthcare providers already have load balancers – hardware, virtual, or cloud-based solutions that help ensure the optimal performance of key medical and business systems. Load balancers alone will not transform the healthcare industry. They won't save lives, prevent clinician burnout, or reverse national death rates. They can, however, be used effectively to help:

- Enhance the patient experience by keeping critical systems up and running and making test results readily accessible
- Improve population health by enabling clinicians to work more efficiently and offer more services for more patients, in the same amount of time
- Support healthcare professionals by underpinning remote access systems that allow hospitals to share services and take advantage of third party specialist services at busy times
- Reduce costs by eliminating unnecessary expenditure and complexity in IT infrastructures.

One fundamental principle of the Quadruple Aim is that hospitals and other healthcare providers should be striving to achieve the four goals – simultaneously. It isn't always easy to focus attention, resources and budget in four directions concurrently. However, in leveraging the capabilities of load balancing, organizations can use this one technology in different ways to work towards achieving improvements in all four priority areas.



What is the Quadruple Aim?

The Quadruple Aim started life as a Triple Aim: 'Care, Health and Cost'. It was taken from an academic paper by Berwick and colleagues[2] and adopted as an improvement framework by the Institute for Healthcare Improvement (IHI), an independent, not-for-profit organization based in Boston, USA[3].

In 2014, academics recognized that burnout among medical professionals was having a detrimental impact on the healthcare industry's ability to achieve the Triple Aim, as "burnout is associated with lower patient satisfaction, reduced health outcomes, and it may increase costs."[4] So, the Triple Aim became the Quadruple Aim to include the need to improve support for healthcare professionals.

The four facets of the Quadruple Aim are to:

1 Enhance the patient experience

In a survey carried out for the California Healthcare Foundation in 2007, more than 60% of doctors reported that their patients sometimes or often experienced long waiting times for diagnostic tests, while 20% claimed tests had to be repeated due to lost results[5]. These are only two issues, evidenced in one state, however, they are indicative of a US-wide failure to deliver a consistent, high-quality patient experience.

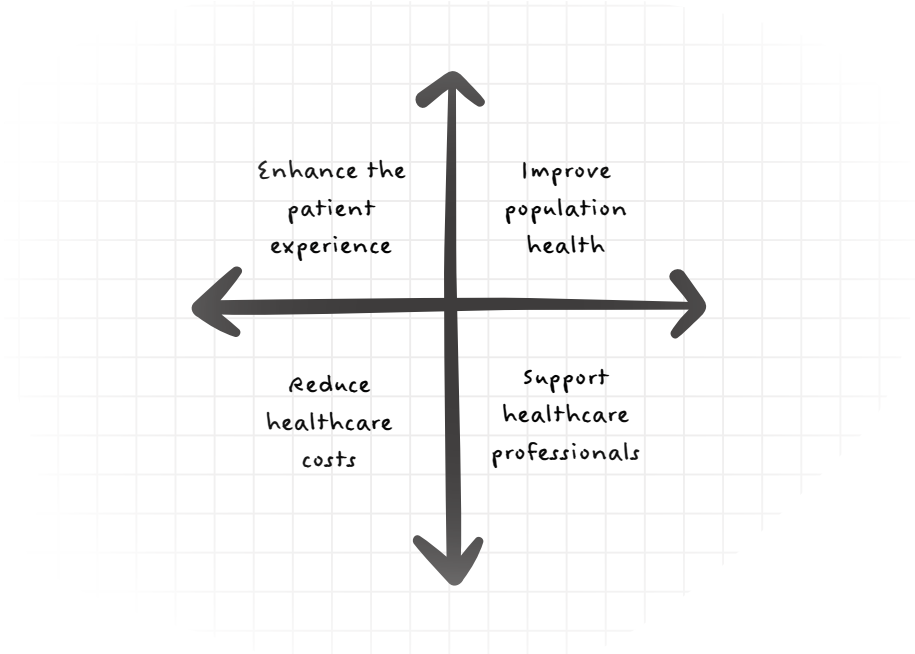
> *"More than 60% of doctors reported that their patients sometimes or often experienced long waiting times for diagnostic tests, while 20% claimed tests had to be repeated due to lost results."*

2 Improve population health

To improve population health, you need to improve more than just healthcare; you need to improve health education and healthy living. But the quality of healthcare and the accessibility of services play a key role in preventing untimely deaths. An academic study published in 2012 provides statistical evidence that the number of preventable deaths in the USA far exceeds that in France, Germany and the UK[6].

2 Berwick DM, Nolan TW, Whittington J. The Triple Aim: Care, Health, And Cost. Health Affairs. 2008.
3 Triple Aim for Populations | IHI - Institute for Healthcare Improvement [Internet]. [cited 2022 Jan 27]. Available from: http://www.ihi.org:80/Topics/TripleAim/Pages/default.aspx
4 Bodenheimer T, Sinsky C. From Triple to Quadruple Aim: Care of the Patient Requires Care of the Provider. The Annals of Family Medicine. 2014.
5 Snapshot: Uncoordinated Care: A Survey of Physician and Patient Experience, 2007. Available from: https://www.chcf.org/wp-content/uploads/2017/12/PDF-UncoordinatedCareSnapshot07.pdf
6 Nolte E, McKee CM. In amenable mortality--deaths avoidable through health care--progress in the US lags that of three European countries. Health Aff (Millwood). 2012. Available from: https://pubmed.ncbi.nlm.nih.gov/22933419/

> *If clinicians – and support staff – are under too much pressure, they will be unable to deliver the high level of care that patients expect and need.*



3 Support healthcare professionals

Originally described as 'improving the work life of those who provide care',[7] this dimension of the Quadruple Aim recognizes that if clinicians – and support staff – are under too much pressure, they will be unable to deliver the high level of care that patients expect and need. One study found that 46% of US physicians experience symptoms of burnout[8], and that was long before COVID-19 heaped on additional pressures.

> *For these healthcare providers, operating cost efficiency will be a fundamental mission.*

4 Reduce healthcare costs

Delivering healthcare cost-effectively is absolutely critical. Indeed, cost reduction is particularly important in the USA, where healthcare expenditure was 16.8% of Gross Domestic Product (GDP) in 2019, as compared to the UK where it was 10.2%[9]. In the USA, 58% of community hospitals are non-profit and 21% are government owned[10]. For these healthcare providers, operating cost efficiency will be a fundamental mission. Even the 21% of community hospitals that are commercial will want to eliminate unnecessary costs to increase their profitability.

7 Bodenheimer T, Sinsky C. From Triple to Quadruple Aim: Care of the Patient Requires Care of the Provider. The Annals of Family Medicine. 2014.
8 Shanafelt TD, Boone S, Tan L, Dyrbye LN, Sotile W, Satele D, et al. Burnout and satisfaction with work-life balance among US physicians relative to the general US population. Arch Intern Med. 2012. Available from: https://pubmed.ncbi.nlm.nih.gov/22911330/
9 Health expenditure and financing [Internet]. [cited 2022 Jan 27]. Available from: https://stats.oecd.org/Index.aspx?DataSetCode=SHA
10 Fast Facts on U.S. Hospitals, 2021 | AHA [Internet]. [cited 2022 Jan 27]. Available from: https://www.aha.org/statistics/fast-facts-us-hospitals

> *Load balancers play a key role within the IT infrastructure of hospitals and other healthcare facilities, helping to ensure that critical medical systems remain available 24/7, 365 days a year, and provide fast, responsive services.*

Are four priorities enough?

Some academics have recently argued that the Quadruple Aim should actually be revised to become a Quintuple Aim, to include the goal of improving equality of access to healthcare.[11] This is another very important measure of healthcare success. In the UK, healthcare inequality occurs due to variations between the policies and resources of different NHS Trusts around the country, and is known colloquially as the 'NHS postcode lottery'. For example, a report by the Medical Technology Group found significant variations in the numbers of patients referred for specialist bowel cancer tests in the English city of Southampton, compared with neighbouring towns of Fareham and Gosport[12].

In the US, however, equality of access can be limited not only by location, but also by access to health insurance. The Harvard Gazette, in 2009, reported that 45,000 annual deaths could be attributed to a lack of health insurance.[13]

So, quadruple could become quintuple and, maybe, someday, quintuple will become sextuple. The definition and number of priorities advocated for healthcare improvement will inevitably evolve and be refined over time. For the time-being, however, this whitepaper will focus on the Quadruple Aim, recognizing that these four metrics are most widely recognized today as being the primary goals for service improvement.

11 Nundy S, Cooper LA, Mate KS. The Quintuple Aim for Health Care Improvement: A New Imperative to Advance Health Equity. JAMA [Internet]. 2022 Jan 21 [cited 2022 Jan 26]; Available from: https://doi.org/10.1001/jama.2021.25181

12 The NHS postcode lottery – alive and well still? [Internet]. Medical Technology Group. 2017 [cited 2022 Jan 26]. Available from: https://mtg.org.uk/the-nhs-postcode-lottery-alive-and-well-still/

13 Alliance DCCH. New study finds 45,000 deaths annually linked to lack of health coverage [Internet]. Harvard Gazette. 2009 [cited 2022 Jan 27]. Available from: https://news.harvard.edu/gazette/story/2009/09/new-study-finds-45000-deaths-annually-linked-to-lack-of-health-coverage/

What role do load balancers play?

Load balancers play a key role within the IT infrastructure of hospitals and other healthcare facilities, helping to ensure that critical medical systems remain available 24/7, 365 days a year, and provide fast, responsive services. Available as hardware devices, software or cloud-based solutions, load balancers intelligently manage the flow of traffic between servers and systems. If one server or system goes down, or starts to perform sluggishly, the load balancer will automatically direct traffic to an alternative, providing seamless application availability and the best possible performance for the user.

Similarly, load balancers can act as an intelligent interface between different systems, including storage systems, data archives and cloud platforms, making it faster for people to retrieve information or access data from remote locations. The more hospitals and medical facilities rely on technology for diagnosing conditions and treating patients, and the more they share services, the more important load balancing technology becomes.

Three fundamental reasons for using load balancing technology in healthcare settings are to:

> *By monitoring the health of application server clusters, load balancers can detect a failure and redirect users to other active servers in the cluster.*

1 Ensure high availability

Load balancing solutions are used by hospitals and medical facilities to prevent downtime in vital systems, which could hamper the rapid diagnosis of conditions and the delivery of care. By monitoring the health of application server clusters, load balancers can detect a failure and redirect users to other active servers in the cluster. Once the failure is resolved, load balancers allow those servers to be seamlessly reintroduced without interrupting the workflow.

The role of this technology is so critical that the leading suppliers of medical imaging systems either supply load balancers with their products, or recommend specific load balancers be used in their configuration. For example, DelfDI, a Canon group company, recommends and installs load balancers alongside its suite of radiology and patient imaging systems, wherever they are installed, in hospitals around the world. It recognizes that load balancers help to ensure the high availability of its potentially life-saving applications.[14]

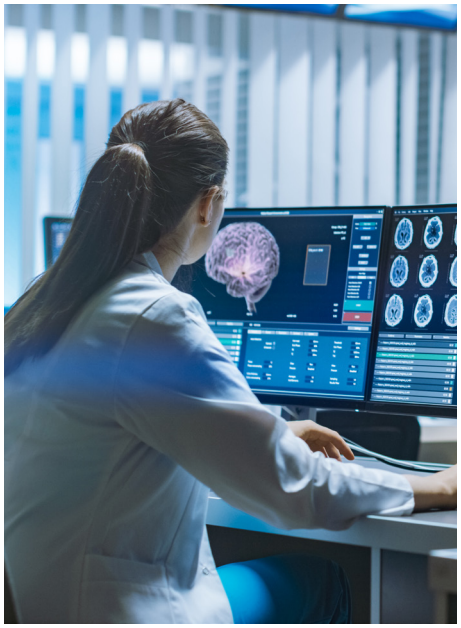
14 Loadbalancer.org case study. Available at: https://pdfs.loadbalancer.org/casestudies/Loadbalancer_DelftDI_Case_Study.pdf

2 Enable integration

Load balancers are also commonly used to help integrate data in disparate systems including imaging systems, electronic health records and billing systems to improve process efficiency. They can be used as a bridge between legacy systems and state-of-the-art, specialized applications, as well as systems in different departments, sites and partner organizations.

For example, a semi-autonomous US government medical agency, that comprises three separate healthcare facilities, used load balancers to introduce a layer of interoperability across its multi-site IT infrastructure and help it function efficiently as a single unit. The load balancers at this organization underpin the Meditech Electronic Healthcare Records system, helping clinicians to deliver a fast, effective service for patients.[15]

> *Load balancers are also commonly used to help integrate data in disparate systems including imaging systems, electronic health records and billing systems to improve process efficiency.*



3 Improve scalability

Demand for healthcare services is high – and steadily increasing due, in part, to an aging population. Usage of critical medical systems is therefore also going to be high and going to grow. As a consequence, all medical systems need to be able to deliver consistently good performance and scale up on demand. As the workload increases, a load balancer will perform application healthchecks and distribute the load across multiple backend servers, delivering optimal performance at scale. Additional compute resources can also be added to the cluster in maintenance mode, without interrupting services. One of the reasons why medical imaging experts such as Fujifilm UK uses load balancers with its medical imaging systems is to ensure scalability. With no bandwidth or throughput limits, the load balancers used by Fujifilm UK enables sudden increases in the use of its medical imaging systems to occur without performance issues and without added costs.[16]

15 Loadbalancer.org case study. Available at: http://pdfs.loadbalancer.org/casestudies/Loadbalancer_Meditech_case_study.pdf
16 Loadbalancer.org case study. Available at: https://pdfs.loadbalancer.org/casestudies/Loadbalancer_Fujifilm_Case_Study.pdf

> *Load balancers don't save lives, but they can improve the reliability of the critical systems that healthcare providers need to save lives.*

How does load balancing support the Quadruple Aim?

While load balancing may seem to be a fairly inconsequential part of the broader IT environment in hospitals and other medical facilities, load balancers can, nonetheless, play a role in helping to achieve improvement in every one of the four metrics of the Quadruple Aim.

An enhanced patient experience

It could never be claimed that load balancers save lives, but they can improve the reliability of the critical systems that healthcare providers need to save lives. They help to ensure, for example, that when a victim of a traffic accident arrives by ambulance at a hospital, the medics can depend on the fact that the MRI scanner will be up and running and able to deliver imagery rapidly, so that life-saving surgery can take place without delay.

A specialist diagnostic center in Nevada uses load balancers for precisely this reason. Recognizing the critical importance of its Radiology Information System (RIS) and Picture Archive and Communication System (PACS), it uses load balancers to ensure they are available 100% of the time and able to deliver the optimal performance expected by 5,000 patients per year[17]. Similarly, an NHS Foundation Trust in north east England uses load balancers to optimally channel DICOM, HL7 and other related traffic to its PACS application servers located on different sites. Now, if an application server fails, the load balancers automatically and instantly direct the traffic to alternative servers, maintaining service availability for users.[18]

Sustainable improvements to population health

Improvements in population health can be brought about – and sustained – by improving the efficiency of processes that deliver patient services. For example, a 2012 study showed that by improving the efficiency of a primary care clinic in the USA, the number of HIV screening tests completed in a day per full-time equivalency provider could be increased by 48%.[19] The study reasonably assumes that offering more screening tests, and screening patients sooner, will improve population health.

Load balancers can be used to improve the efficiency of healthcare professionals, including those who work across multiple sites and healthcare facilities. An NHS Trust in England uses load balancers to give over 2,000 community healthcare staff access to their desktops, using any device, over any network and from any site.[20] This improved access to medical data enables them to work more efficiently and therefore deliver high quality services for the local population, which can improve health outcomes.

17 Loadbalancer.org case study. Available from: https://pdfs.loadbalancer.org/casestudies/Loadbalancer_Reno_Case_Study.pdf
18 Case study available at: https://pdfs.loadbalancer.org/casestudies/Loadbalancer_North_Lincs_NHS_Trust_Case_Study.pdf
19 Arnetz BB, Goetz CM, Arnetz JE, Sudan S, vanSchagen J, Piersma K, et al. Enhancing healthcare efficiency to achieve the Quadruple Aim: an exploratory study. BMC Res Notes. 2020.
20 Loadbalancer.org case study. Available from: https://pdfs.loadbalancer.org/casestudies/Loadbalancer_Nottinghamshire_NHS_Trust_Case_Study.pdf

Greater job satisfaction for healthcare professionals

Burnout, as already discussed, is a major problem among healthcare professionals, but it's not an easy one to remedy. The challenges are exasperated in many branches of medicine by staff shortages. In pathology, for example, the number of active pathologists in the USA decreased by 17.53% between 2007 and 2017.[21] One answer may lie in hospitals pooling their resources, sharing services and taking advantage of external partners – but to do this, they need to be able to share data.

Load balancing technology can be used effectively to ensure data is always available to those who need it, wherever they are. 4ways Diagnostics provides remote radiology services including colonography, mammography and cardiac scans, to support hospitals when they are overloaded. It uses load balancers to ensure that its medical images can be easily, securely and rapidly retrieved by staff and partners, from any location, from its primary and contingency data centers.[22] This is just one example, but it shows how hospitals can gain third party support for their in-house staff, without having to compromise on the accessibility of medical results.

> *Load balancing technology can be used effectively to ensure data is always available to those who need it, wherever they are.*

Reduced IT costs in healthcare settings

New technologies like artificial intelligence, machine learning and remote sensing have the potential to transform many aspects of healthcare – but come at a cost. This means that unnecessary expenses in other aspects of IT provision need to be routed out to free up budget for technologies that can really make a difference. Currently, IT makes up one of the largest proportions of hospital administration costs, so every investment in IT needs to be carefully scrutinized to make sure it adds value. Load balancers can be used to ensure that organizations make optimal use of all of their IT resources. Rather than having back-up servers lying idle 'just in case', hospitals can avail of all their servers, using load balancing to ensure that if a failure in one device occurs, all traffic can be instantly diverted to another.

It is worth noting here that the price of load balancers can vary enormously. The more expensive options are typically packed full of features, but in reality, very few of these features are used in hospital settings. Healthcare organizations can therefore often reduce their IT costs by replacing an over-complicated load balancer with a simpler but more than adequate load balancer. They can also further optimize limited resources by adopting a single technology across entire sites.

21 Metter DM, Colgan TJ, Leung ST, Timmons CF, Park JY. Trends in the US and Canadian Pathologist Workforces From 2007 to 2017. JAMA Network Open 2019. Available from: https://jamanetwork.com/journals/jamanetworkopen/fullarticle/2734800 (accessed 16 March 2021

22 Loadbalancer.org case study. Available from: https://pdfs.loadbalancer.org/casestudies/Loadbalancer-4ways-case-study.pdf

What should you look for in a load balancer vendor?

There are many different types of load balancers available on the market currently. Some are based on open source technology, while others are built on proprietary software. To achieve the best return on investment and optimal performance, healthcare providers, hospitals and other medical facilities may wish to consider the following criteria.

Experience in healthcare

Healthcare organizations have incredibly sensitive data and require exceptional application performance. It is, therefore, advisable to look for a load balancing vendor that understands these pressures and has long experience of load balancing critical patient care systems. Loadbalancer.org, for example, has worked with customers in this sector for over 20 years and is the preferred partner of several key vendors of healthcare solutions, including Philips and Fujifilm.

Site-wide licensing

Most hospitals and medical facilities use multiple load balancers, often spread across different buildings on a large site. Having separate licenses for all these solutions (even assuming they are all from one vendor) will add cost and complexity. It is advisable to consolidate all load balancing with a single vendor that offers flexible site-wide licenses. Then, organizations can expand the number of load balancing instances that they use, on demand, within a single, cost-effective, annual license agreement.

Necessary features

As previously discussed, many load balancers on the market today are packed full of features that hospitals rarely use. In evaluating load balancing products, take the time to clearly understand which features are absolutely necessary, and which are not. In many cases, hospitals can save money by investing in products that meet their needs, rather than over-spending on products that exceed their needs.

Centralized management

Managing and maintaining large numbers of load balancers can prove complex and time-consuming. In particular, it can be challenging to plan and implement the roll-out of security patches to multiple devices. Hospitals that have multiple load balancers should ask vendors about central management solutions that enable all deployed load balancers to be controlled from a centralized position, making it easier and faster to roll out security patches and other updates.

Consultative support

Being able to contact a technical support team directly – without having to go through a partner – is a huge advantage, not only in the event of unexpected issues. It can be incredibly helpful to be able to discuss your load balancing plans with load balancing experts and get advice about the best way to optimize deployments. Some organizations offer this kind of consultative support as standard, for no additional cost, whereas others charge huge supplementary fees for their professional services.

About Loadbalancer.org

Loadbalancer.org's mission is to ensure that its clients' businesses are never interrupted. The load balancer experts ask the right questions to get to the heart of what matters, bringing a depth of understanding to each deployment. Experience enables Loadbalancer.org engineers to design less complex, unbreakable solutions - and to provide exceptional personalized support.

LOADBALANCER

Visit us: www.loadbalancer.org

Phone us: +44 (0)330 380 1064

Phone us: +1 833 274 2566

Email us: info@loadbalancer.org

Follow us: @loadbalancer.org