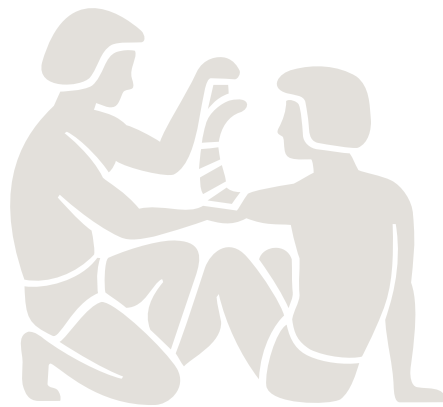


Nina Tjomsland and Ken Morallee

One Million Lives

A shared goal for 2030



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Electronic version

helping-save-lives.com

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- videos
- reports and papers that have stimulated the goal for 2030 and are listed in the bibliography.

Periodically, these links will be updated.



One Million Lives

A shared goal for 2030

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Tayeeba was not breathing at birth but midwife Sakina, who had been trained in the Helping Babies Breathe (HBB) program, knew what to do. Sakina saved Tayeeba's life. Today, Tayeeba is a healthy and thriving girl, full of energy and hope for the future



*Opposite page:
Tayeeba and her mother, Ritka.*

A shared goal

Helping save 1 million more lives. Every year. By 2030.
This is the audacious goal Laerdal has established. Nothing less.

The key word is “helping”. No-one at Laerdal would claim they were saving lives; their role is to develop educational and therapy solutions and services that help train and equip those who do from lay people, ambulance dispatchers, and community first responders through to healthcare workers on ambulances and in hospitals. Laerdal can only do this by working with partners in professional associations, NGOs and government bodies to develop the necessary programs and actions for widespread implementation.

The guiding stars for this collaboration are the Sustainable Development Goals (SDGs), established by the UN in 2016, with SDG3 for good health and well-being at its core. In addition to having a goal of reducing maternal, neonatal and child mortality, SDG3 also addresses accidents and non-communicable diseases including sudden cardiac arrest.



SDG 3 goals (extracts)

- 3.1 By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births.
- 3.2 By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1000 live births and under-5 mortality to at least as low as 25 per 1000 live births.
- 3.4 By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being.
- 3.6 By 2020, halve the number of global deaths and injuries from road traffic accidents.
- 3.8 Achieve universal health coverage, including financial risk protection, access to quality essential healthcare services and access to safe, effective, quality and affordable essential medicines and vaccines for all.
- 3.9 By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination.

A changing world

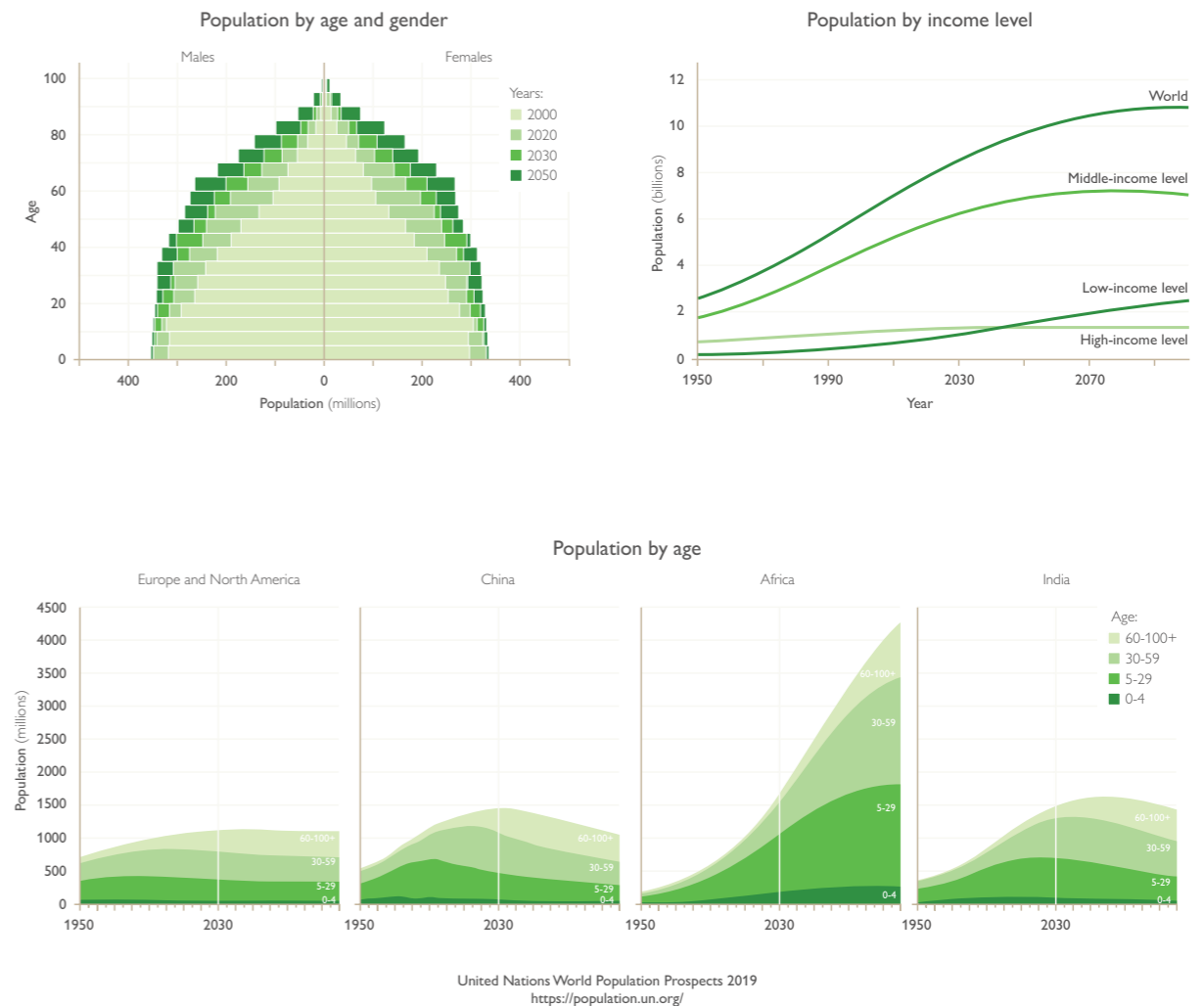
When Laerdal was established in 1940, the world's population was just over 2 billion. Today it exceeds 7.5 billion. By 2030 it is projected to reach 8.5 billion – with 5 billion living in Asia and 1.7 billion in Africa.

And the age distribution of the population is changing. In 2017 there were about 960 million people aged 60 years or over, more than double the number in 1980, and this number is expected to double again by 2050 to 2.2 billion with 80% living in developing regions. This ever-ageing population with numerous health problems places increasing stress on health and social care systems.

These demographic changes are faster than at any time in history. To deal with these and to meet people's increased expectations with advances in medical care, healthcare expenditure in OECD countries has had to grow at an average rate of 4%, double that of the growth in national income. This is not sustainable. The resources are just not there to meet future demand. New approaches are needed. There are even severe challenges now in the richest country in the world, the USA. Even though the USA spends 18% of its national income on health care, the maternal mortality rate has more than doubled from 10.3 per 100,000 live births in 1991 to 23.8 in 2014: over 700 deaths per annum, and of these two thirds are preventable. Also, deaths from medical errors in US hospitals are estimated to exceed 250,000 per annum.

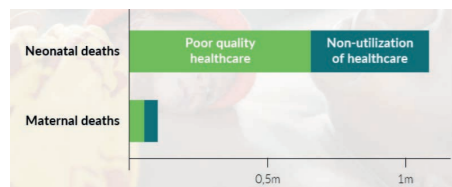
“I envision a world where everyone can lead healthy and productive lives, regardless of who they are or where they live.”

Teodros Adhanom
WHO Secretary General



Quality in Health Care

In a landmark paper published in the *Lancet* medical journal in 2018, researchers estimated that 8.6 million deaths per year in 137 low- and middle-income countries (LMICs) are due to inadequate access to quality health care. Of these, 40% are people who did not access the health system, but 60% (5.0 million) are people who sought access but received poor-quality health care.



Such poor-quality health care resulted in 82 deaths per 100,000 people in LMICs: an enormous and preventable burden. And because deaths in LMICs occur at a younger age, poor-quality health care takes a large toll on years of life lost, estimated at 224 million, about 50% of which are in Asia.

Cardiovascular disease made up 33% of the preventable deaths (2.8 million) of which 84% were caused by use of poor-quality health services. Deaths from neonatal conditions and road accidents were second and fourth highest.

Trends and opportunities

Trends in health care and education and advances in technology and delivery models all feed into improved opportunities for lifesaving.

Examples described in later chapters include:

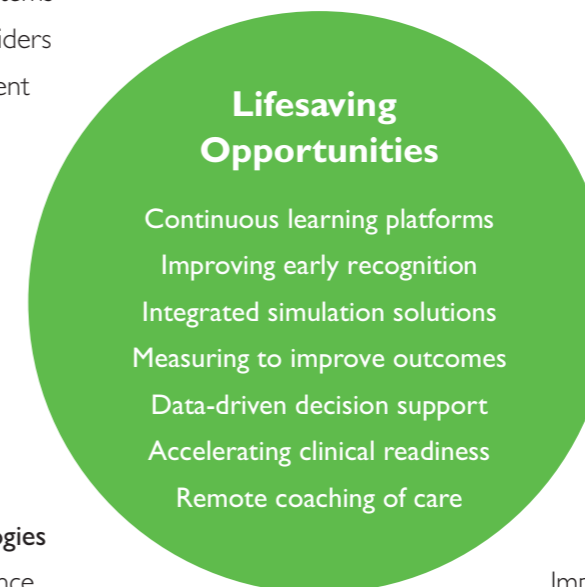
- digital advances in training products and methodologies and the widespread use of mobile phones and Artificial Intelligence to maximise the impact of the first resuscitation team in the community;
- mobile apps to enrol and activate a community of first responders;
- low-dose, high-frequency educational programs to move health care away from big-dose, infrequent training to focussing on continuous improvement of competence;
- tailored refresher training based on individual healthcare workers' needs;
- on-site training with high fidelity simulators to improve the quality of the team response to emergencies;
- development of digital platforms and lifesaving medical devices to collect data on more than 27,000 live births for analysis and improvement of the care of babies.

Healthcare trends

- Patient safety and quality focus
- Ageing population
- Decentralised systems
- Shortage of providers
- Cost containment

Educational trends

- Peer-to-peer learning
- Self-directed learning
- Rapid feedback loops
- Mobile/remote learning
- Adaptive learning



Enabling technologies

- Artificial Intelligence
- Connected people and devices
- Augmented, Virtual, Mixed Reality
- Cloud computing
- Voice recognition

Delivery models

- Implementation partnerships
- Platform as a Service
- Subscriptions and add-ons
- Outcome-based risk sharing
- Pay per use

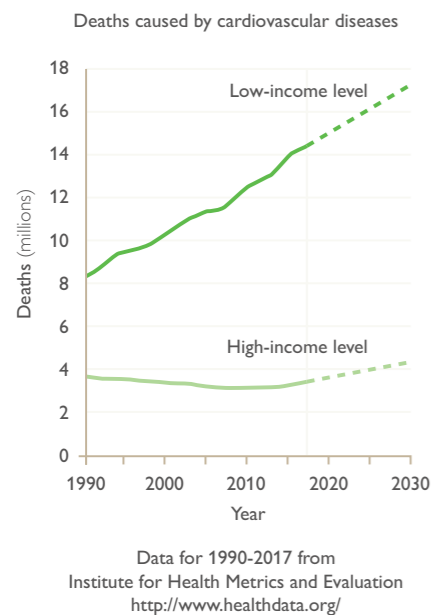
Wellbeing for all

SDG 3 reads Health and well-being for all. Well-being relates to quality of life, and outcome should thus not be confined to whether a patient lives or dies, but should also include quality of life.

This aspect is being addressed by measurements that have come more into use in recent years:

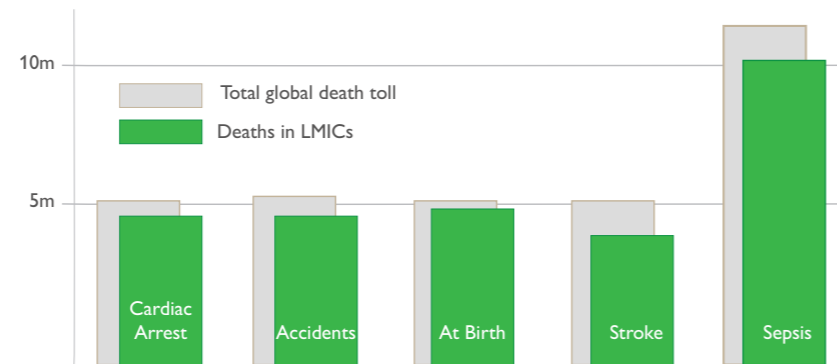
DALY (Disability-Adjusted Life Year) is a measure of overall disease burden, expressed as the number of years lost due to ill-health, disability or early death. It was developed in the 1990s as a way of comparing the overall health and life expectancy of different countries.

HALE (Health-Adjusted Life Expectancy) is a measure of population health that takes into account mortality and morbidity. It adjusts overall life expectancy by the amount of time lived in less than perfect health. The American Heart Association has defined its 2030 goal as helping increase global health-adjusted life expectancy from 66 to at least 68 years across the US and from 64 to at least 67 years across the world.



Reaching one million lives and 50 million life years

According to estimates, each of three categories - cardiac arrest, accidents, and births – accounts for about 5 million untimely deaths, every year. In total, this corresponds to every fourth death globally. An estimated 90% of these 15 million fatalities occur in low- and middle-income countries (LMICs): 98% of the birth-related deaths, 88% of the accidental deaths, and - contrary to common impressions - 86% of deaths due to cardiac arrest.



Cardiac arrest has long been associated with lifestyles in affluent societies and still are. But over the 60 years since the implementation of modern cardiac resuscitation began in 1960, emphasis on factors such as preventive medicines, exercise, reduction in smoking, controlling blood pressure, and obesity have helped cut the rate of fatalities from sudden cardiac arrest in these parts of the world by an astonishing 60%. Now, research shows a dramatically different pattern on the world map, where the rates of such fatalities in Asian and some African nations keep increasing. At the same time, unnecessary deaths from accidents are developing in a similar way.

Helping save about 5% of the lives lost at birth and due to cardiac arrests and accidents amounts to 800,000 extra lives saved per year. Added to these numbers comes the vision of progress in fields that lie outside SDG3: helping save 100,000 of the millions of lives that are now lost each year because of medical errors in hospital care or through lack of access to safe anaesthesia and surgery in LMICs; and helping save 100,000 lives in other areas where timely interventions are critical, e.g. stroke and sepsis. This brings the total goal up to one million extra lives saved by 2030. Ambitious but achievable.

	Lives per year	Years per patient	Life years
Newborn	500,000	70	35,000,000
Maternal	50,000	50	2,500,000
Cardiac Arrest	150,000	17	2,500,000
Accidents	100,000	50	5,000,000
Other time-critical emergencies, including stroke and sepsis	100,000	25	2,500,000
Patient safety, including global surgery and anaesthesia	100,000	25	2,500,000
Total	1,000,000		50,000,000

Focussing for success

To maximise the chance of success, Laerdal with its partners will focus on helping to improve the coverage, quality and efficiency, safety, and equity of health care through

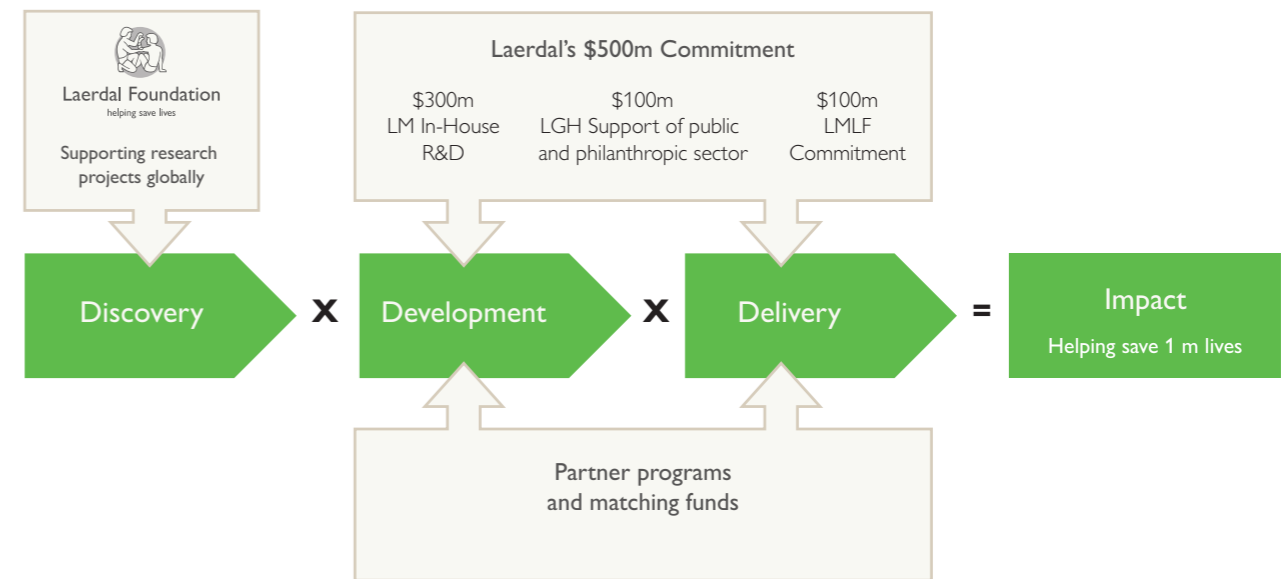
- early interventions with high lifesaving potential and lower cost to society;
- leveraging enabling technologies to improve translation of learning to patient outcome;
- collaborative initiatives for the scale up and implementation of developments.



There are four entities to support achievement of the goal: Laerdal Medical with its 1,600 people in 25 countries; the Laerdal Foundation which has funded 2,000 research projects in acute medicine and global health; the not-for-profit company Laerdal Global Health; and the impact investment Millions Lives Fund supporting implementation and scaling of transformative innovations.

The total commitment of resources (excluding the Laerdal Foundation) over the next ten years will amount to \$500m with an additional \$100m in matching funds being sought from other investors.

Innovation = Impact



A rich heritage

Right from the day in 1940 when Åsmund S. Lærdal founded his company in Stavanger, Norway, he applied his firm basic principles which already then encompassed the concept of stakeholders and teamwork. One major stakeholder was clearly defined: the child. Producing high-quality books and toys for children meant providing joy. During WWII, raw materials could be impossible to find. Under cover of the dark nights he travelled illegally along the fjords to buy wood for toys. He and his team kept developing and improving a richness of new varieties – always with an eye on stimulating the child's active involvement and imagination.

Soon after the war, he travelled to the USA to search for new materials and found the basics for soft plastic. After intensive experiments and work to develop pioneering processes and machines, the company rapidly became one of the European leaders in quality dolls and indestructible model cars. The Anne dolls – in ever new but always beautiful versions - were soft and cuddly; the cars were so precisely modelled that collecting them became a dream for boys as far away as Hong Kong.

About one million Anne dolls were made in the 1950s in a hundred different models. Today they are collectors' items.

The Tomte toy cars introduced in the mid 1950s were exported to over 50 countries. (Photo from the Norwegian Childhood Museum in Stavanger.)



Moving into life saving

When the Laerdal expertise in soft plastics led the Norwegian Civil Defence to ask the company to develop imitation wounds for training, Åsmund persuaded the emergency department of the University Hospital in Oslo to let him install a camera for them to provide the necessary details. Collaboration with an experienced surgeon yielded accurate models of relevant wounds. A detailed and thorough process resulted in Practoplast kits with 33 different wound imitations; this kit was adopted on several continents.

Contacts made through the work with wound imitations alerted Åsmund to the group of physicians and engineers in Baltimore that had developed a new and much more effective method for resuscitation, involving mouth-to-mouth breathing. He was instantly receptive – and in this case, his interest had a strong emotional element as well, after the experience of having found his little son, Tore, lifeless in the water.

The big question was how people could learn this new technique. After testing a prototype face mask on spluttering volunteers, Åsmund soon became convinced that a life-size manikin would have the greatest potential. He appealed to Stavanger's only anaesthesiologist at the time, Bjørn Lind, for help, and the two worked closely together for a year to make every detail anatomically correct. The name was to be Resusci Anne – drawing a line back to the play dolls and the expertise needed to produce them. Quality was an absolute, but at the same time the price had to be affordable: "It is much more meaningful to make 10,000 manikins at NOK 1,000 each than 1,000 manikins at NOK 10,000," said Åsmund. He was adamant: "When people choose to exchange their money for a Laerdal product the exchange must benefit both."

When Åsmund saved his son

When the two older siblings, Astrid and Åge, called out to their parents that their little brother had fallen into the water, Åsmund S. Lærdal reacted instinctively. Thanks to the air inside his rain-suit, two-year old Tore was floating but face down, unconscious and icy cold. Having held him upside-down and shaken him to drain out the water and help him breathe, Åsmund ran uphill to bring him into the cottage,

stripped himself and Tore, and lay down in the bed cuddling him to warm him up. Åsmund and his wife, Margit, had previously lost their first child, Signe Marie, in a neonatal hospital epidemic. The near drowning of Tore on top of this tragedy was all the more traumatic to them and contributed to Åsmund's personal and unspoken motivation for what he later devoted his life to.



Opposite page: Åsmund S. Lærdal practising resuscitation on an early Resusci Anne.



Alle skolebarn skal lære Munn-til-munn-metoden

Dukken „Resusci Anne“ brukes til demonstrasjoner



Overlege Lind demonstrerer Munn til munn-metoden på dukken «Resusci Anne».

“All school children are to learn the mouth-to-mouth method” – media coverage of the successful pioneer project.

gen. Man regner å ha den ferdig utpå våren. Slike dukker ble demonstrert over hele landet i går. Det er med andre ord en meget god plan. Sparebankene her i mandager. Målet i Stavanger i går ble ledet av helse- og sosialdirektør Arne R. Husebo.

When Åsmund brought the prototype Resusci Anne to the US in 1960 and met the resuscitation pioneers Peter Safar and Archer S. Gordon, the chemistry was instant and Peter and Åsmund became lifelong close friends and collaborators.

The year 1960 also led to ground-breaking research: having become a strong advocate, Bjørn Lind played a key role when manikins were used for the first large-scale training of school children. The outcome was scientifically recorded, analysed and published in the leading *Journal of the American Medical Association, JAMA*. Norway had shown the way: every school child could learn how to save a life.

New concept: the trained bystander

Åsmund S. Lærdal initiated and sponsored the first international symposium on emergency resuscitation in Stavanger a year later. The conclusion was simple and clear: first-aid workers of all categories, school children and the general public should be taught mouth-to-mouth resuscitation, and the training should be compulsory for all school children. Åsmund expressed the way forward: “Implement what has been shown to work, and drive therapy through education.”

At this stage, compressions were considered too risky for lay people to administer, being reserved for professional health carers and certified life savers. But Peter Safar had already suggested a flexible chest ring inside Resusci Anne for compression simulation. In his quiet, almost self-effacing but determinedly efficient way, Åsmund was a persistent key mover. He supported the production and printing in 12 languages of Safar’s CPR manual and enabled Norwegian anaesthesiologists to organise a new international symposium in 1967, which recommended that all health personnel should be trained in the full CPR method. Seven years later the American Heart Association (AHA) decided to recommend that lay people should also train in chest compression; any chest injuries would be outweighed by the chance of preventing lasting brain damage or death.

That same year Åsmund established Laerdal Medical Corporation in Armonk, NY – the first step in creating an international company. In line with this, the Norwegian vowel ‘æ’ in the company name was replaced by the more easily internationally grasped ‘ae’. The family, however, retained the Norwegian spelling of the name.

At the 50th anniversary of modern life saving in 2010, the AHA estimated that about 350 million people around the world had been trained in CPR, most of them on Resusci Anne. CPR was recognized as one of the most important public health initiatives in the last two generations and is now estimated to have contributed to saving at least 2 million lives.

Never satisfied with the status quo

Åsmund was always seeking to improve things. He kept listening and discussing needs for innovation with his increasing network of users and specialists. Resusci Anne gained a family: Resusci Andy and Resusci Baby, and, two decades later, Resusci Junior. Resusci Anne herself acquired innovative, performance-recording features to address the AHA’s desire for trainees to “Practice to Perfection”. As other urgent needs became clear to Åsmund, he responded with the Resusci Folding Bag – the predecessor to the world-leading Silicone Resuscitator launched in the 1980s. Other early innovations were the Laerdal Pocket Mask to address some concerns about cross-infection when administering mouth-to-mouth resuscitation; and the Laerdal Suction Unit in response to a request from the US Department of Health for a portable aspirator. These therapy products are all still manufactured and sold worldwide today, more than 50 years on from their introduction.

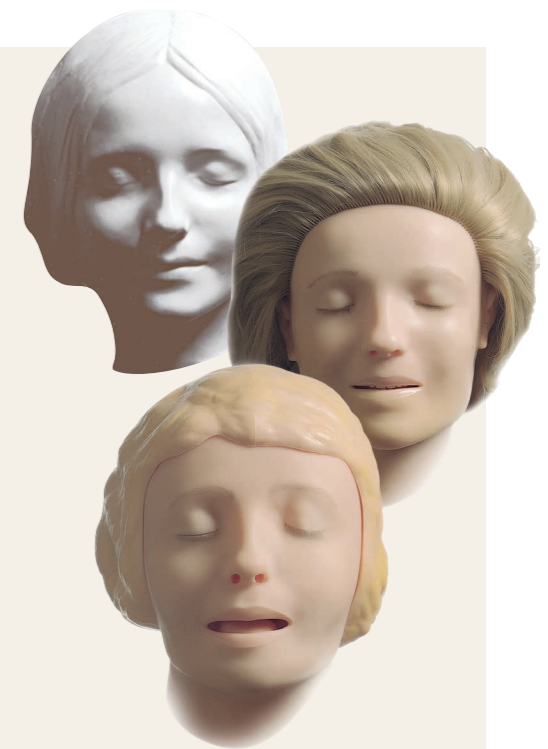


The inventor and industrialist, the father of modern resuscitation, and the specialist who helped develop the manikin and demonstrated that even school children could learn by using her: Åsmund S. Lærdal, Peter Safar and Bjørn Lind.

Girl from the River Seine

In the 1950s, a person who did not breathe was considered dead. One important question was the face of the manikin: “How could it appear dead and yet not be too scary to breathe into?” Åsmund always immersed himself in a problem, thinking and discussing with his nearest collaborators and thinking again. In this case he found the answer in a face mask in the home of his parents-in-law. In the late 1800s, a Paris modeller of death masks had been so struck by the serene expression of a beautiful young woman who was found drowned in the River Seine that he made a cast for what was to become a bestseller: the enigmatic “L’Inconnue”, the unknown.

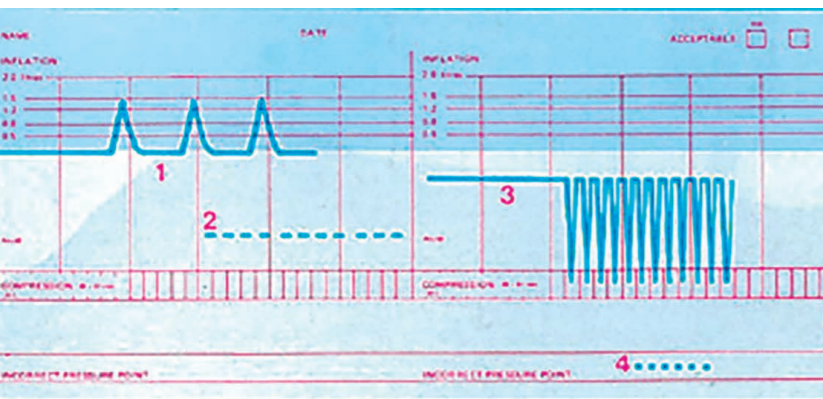
Åsmund commissioned the Danish sculptor, Emma Mathiassen, who had shaped the face of the Anne dolls, to create a face for Resusci Anne based on this mask. In this way, “L’Inconnue” has played her part in helping save millions of lives around the world and continues to help convince learners that they are able and willing to act when a life is at stake. The face of death became the face of life.





The vision of helping low-income countries

Even before starting his own company, Åsmund S. Lærdal had told his wife-to-be, Margit, of his dream to make so much money that he could afford to give away half. All along, he had provided direct financial support to the mission of helping saving lives, mostly behind the scenes. In 1980, he finalised his plans for the Laerdal Foundation for Acute Medicine and provided it with a starting capital of NOK 10 million (\$1.1m). Over the years, this foundation has supported close to 2,000 research projects, in recent years with annual grants totalling up to NOK 40 million.



The Recording Resusci Anne provided feedback, printing out an accurate recording of ventilation and compression quality.

Also, Åsmund thought about handing over the company – his son Tore had joined Laerdal in 1975 after graduating – and devoting his own energies to help low-income countries, in the sense of helping people to help themselves. As he expressed it: “Equipping the people not with tractors but with better spades.”

However, Åsmund S. Lærdal became seriously ill and died in November 1981 before the Foundation’s first award ceremony. Tore was not yet 30, but with the mission in his blood he shouldered the full responsibility for running the company. 30 years later, he realised his father’s vision by establishing Laerdal Global Health.

Promoting mass training

In 1982, the Laerdal Foundation helped initiate and support an international conference for CPR trainers in London, where the AHA presented their support programs for basic and advanced life support. This example from the US stimulated health authorities, schools, rescue organisations and Laerdal to collaborate on projects for mass CPR training in the Stavanger region of Norway.

“Without Laerdal products, CPR would never have been implemented so rapidly and widely as was the case, in particular among lay people who are the vital first link in the life support chain.”



Peter Safar

“The father of modern resuscitation”

Opposite page: team training with equipment including HeartStart MRx and the Laerdal Silicone Resuscitator.



These demonstrated that a two-hour course sufficed to train trainers, and successful training of 5,000 lay persons over just two weekends pointed to great potential.

Inspired by these experiences, Stig Holmberg in Gothenburg developed a Swedish CPR training model, primarily aimed at healthcare personnel. Laerdal contributed with a training program and sponsored thousands of large posters for hospitals and health institutions: complex algorithms were given a simple-to-grasp expression, making them easy to learn. These posters proved so popular that special editions were added, for rescuing children and infants. Over the years, posters in many languages were printed for the European Resuscitation Council for displaying in thousands of hospital emergency rooms and training sites. In addition, pocket-size versions were supplied for use as personal reminders.

Moving into hi-tech

By the mid-80s Laerdal's internationalisation had progressed rapidly. Whereas the number of employees in Stavanger remained at about 350, sales companies in eight countries had increased the total employed to about 600. US experiences drew Laerdal's attention to the value of early defibrillation as well as CPR to improve survival from cardiac arrest.

This spurred a move into hi-tech. For the first time Laerdal decided on a joint venture with another commercial company, First Medic in Seattle, resulting in Heartstart 2000 – the first generation “intelligent” machine for the crucial shocking needed to restart an arrested heart. Such machines are called automated external defibrillators (AEDs). Till then, defibrillation had only been practical in hospital settings and in a small number of emergency services with highly trained personnel; now the goal became for all EMS personnel to start CPR within four minutes of the out-of-hospital cardiac arrest and defibrillate within eight minutes. The use of AEDs facilitated this because they required less training to use. Also, importantly, Heartstart 2000 logged vital data allowing for medical quality assurance, overcoming reservations from some quarters about EMS personnel defibrillating patients. Upgrades to Heartstart 2000 followed and a few years later led to an alliance with Hewlett Packard (subsequently Philips Medical) and further innovations in early defibrillation. This alliance lasted over 20 years – extraordinary for corporate alliances.



Heartstart defibrillator

Another long-standing alliance, the one with the AHA, led to Laerdal's purchase of Actronics, a company leasing an AHA-owned patent. Actronics was pioneering the use of computers for training and needed venture capital; this led to the development of the HeartSim cardiac rhythm simulator, a precursor to the e-learning suite of products in use today.

Recognising errors – and learning from them

In the '90s, John Schaefer and René Gonzalez in Pittsburgh tinkered to equip an extremely costly and rare simulator – which was reserved for research only – with crucial airway functions. Medical Plastics Laboratory (MPL) in Texas acquired exclusive rights to use their subsequent patent in its manikins, at a time when MPL and Laerdal were discussing a joint venture to update Resusci Anne. Laerdal acquired MPL around 2000 – the year after the Institute of Medicine in the US had presented its landmark report “To Err is Human”, estimating that up to 100,000 lives were lost every year due to medical errors in the US alone. The report listed its arguments for patient simulation training: optimally efficient learning method; realistic preparation for rare, difficult cases; and allowing errors to be made without harm to patients, analysing them, and repeating the team's efforts in order to improve.

This triggered the development of SimMan by combining MPL's airway torso trainer with the Laerdal HeartSim rhythm simulator. The result cost a fraction of previous simulators and was eminently suited for both training and research, causing a true disruption - a revolution not only in the training itself, but in the culture by admitting errors, making it natural and positive to discuss them in constructive ways and improve procedure, and working to avoid errors. It was an instant hit: simulation centres were set up on several continents based around SimMan.

Over the years, constant collaboration on further developments yielded a range of programs and products, among them the Nursing Anne Simulator. Both the scope of the nursing role and the requirements for training nurses and nursing students have changed dramatically. Practising core skills with the different modules of Nursing Anne enhances clinical knowledge, allows trainees to experience highly realistic patient encounters and in these ways prepare them for the highest level of care.



The first SimMan, launched in 2002.

The contrast: low-tech Mini Anne

At the same time as this hi-tech revolution had begun, the AHA challenged Laerdal to collaborate in developing a dramatically simplified and low-cost, video-based CPR program for lay people that could be delivered in 30 minutes – well within the time of a school class – compared with two to four hours for traditional courses. 30 years after the CPR pioneers had prepared the ground for mass training, the number of bystanders ready and willing to act immediately was still far too low in many communities. The materials for complete and efficient hands-on training should cost less than \$30.

The result was the Mini Anne kit which was proven to be a very effective training tool in extensive evaluations. It was launched by the AHA in New York in 2005 under the name CPR Anytime. In Denmark, Trygfonden, the Tryg Foundation, collaborated with the Danish Resuscitation Council and Red Cross to offer a Mini Anne kit to every 13-year old. Training the young, who will live the longest, is vital. Letting them keep the kit meant that they could convey their proud new skills especially to more elderly family members - the ones who are most likely to be faced with a cardiac arrest in their homes.

A new opening: Laerdal Global Health

In 2006, the Norwegian anaesthetist, Mads Gilbert, drew Tore Lærdal's attention to the area which now accounts for the largest share of the Million Lives goal: maternal and newborn deaths. The American Academy of Pediatrics (AAP) believed that the key was educational methodology that increased both competence and confidence, and they partnered with Laerdal to help advance educational science and resources needed for training in neonatal resuscitation.

The AAP had created the Neonatal Resuscitation Program course for the US, and this had been rolled out to 120 mainly high-income countries (HICs). However, this program was too complex and resource demanding to be used widely in low- and middle-income countries (LMICs), and increased attention at the time on the UN Millennium Development Goal 4 made clear that a new approach was needed. A Laerdal team collaborated with the AAP to develop the NeoNatalie simulator and helped draft the educational materials. The Helping Babies Breathe program was on its way. This led to contacts with Jhpiego, an NGO based in Baltimore, US, whose focus was on the well-being of the mothers.

But the enormous scale of the task ahead, to reduce newborn and maternal mortality, called for a wider network of partners and alliances. To facilitate this, in 2010 Tore Lærdal established the not-for-profit company, Laerdal Global Health (LGH). Turning his full attention to this new venture he became the leader of a small entrepreneurial team. The global health alliances and programs that followed are described in a later chapter.

A key element of all these programs was Laerdal's highly respected expertise in visual expression. Right from the beginning, Åsmund S. Laerdal had stressed the importance of visual clarity and attractiveness by commissioning leading artists to design his children's books and his dolls. This emphasis remains a key element, leading to specialists in education working ceaselessly to reduce visual programs to the essential and instantly graspable, while ensuring that any anatomical details are correct. As a result, training programs including the LGH ones are easily adjusted to overcome language differences and even shortcomings in literacy.



13-year old Hanne Haug, in Våland School, Stavanger, training to become a life saver.

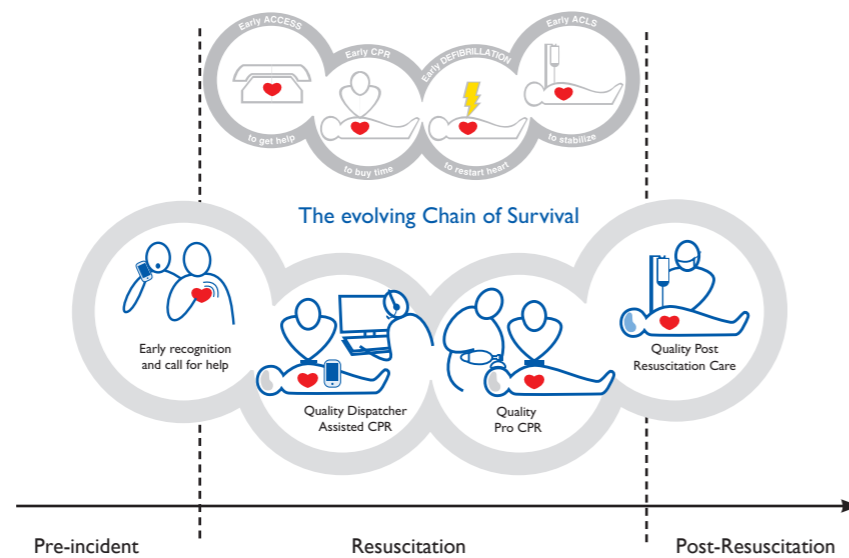


Shelisha and Khalif's story

The family had gathered for a barbecue at their London home in the UK. Shelisha was upstairs with her son, Shylio, when she heard a bloodcurdling scream and ran downstairs. Outside, her sister, brother and dad had found her nephew, Khalif, in the pond and pulled him out. The two-year old was lifeless. Having been trained in CPR at work, Shelisha immediately began chest compressions and rescue breathing. "I was very calm, almost robotic; I knew I had to continue without stopping," she said later. When the ambulance arrived after 15 minutes and the paramedics took over, they told the family that there was a faint heartbeat – but Khalif was still unconscious. Rushed to hospital, he was transferred to intensive care where he made a full recovery.

Improving survival in the community

Sudden cardiac arrest in the community is still a major cause of death despite significant advances in prevention and therapy over the last 60 years. The visual metaphor for treatment of such cardiac arrests has evolved through advances in medical and educational science into what is called the Chain of Survival. Each circle represents one step in the chain from the bystander's recognition of the emergency; calling for help and being coached by the dispatcher in applying CPR; high performance CPR and early defibrillation by first responders or Emergency Medical Technicians; further therapy and stabilisation by paramedics; and finally hospital care.



Opposite page: Shelisha with her beloved nephew, Khalif.



Mr Ha's story

Having finished the marathon track of a triathlon event in Seoul, South Korea, Mr. Ha (53), suddenly collapsed. The emergency team from Hallym University Hospital arrived within 3 minutes. After 1 minute of CPR and a single AED shock, his heart resumed beating. He was still unconscious, but high quality hospital care had him fully recovered after a few hours.

A professional runner for many years, Mr. Ha had attended several CPR courses, and is able to appreciate fully the importance of an effective Chain of Survival. Having resumed running, he is now an enthusiastic CPR supporter on every marathon and all IronMan games.

This chapter will address all the links in the Chain of Survival, except for hospital care which will be covered in the next chapter.

Another version of the Chain of Survival includes a circle before bystander intervention: early prevention. And measures such as exercise, diet, and drug therapy to control cholesterol and blood pressure have been very effective in reducing cardiovascular disease in high-income countries (HICs).

However, although the emphasis until the last decade was on HICs, cardiac arrest is not only a problem in such societies. In fact, as mentioned in the opening chapter, 86% of all global cardiac arrests are estimated to occur in low- and middle-income countries (LMICs) where survival rates are lowest and the opportunity for impact is greatest. Numerous studies show that survival in HICs averages about 50 per million population with the highest performing centres exceeding 100 per million population. The survival data for LMICs is poor but the current average survival rate is believed to be well under 5 per million population. The table shows the potential for lives to be saved if everyone approached the performance of the best: a total of more than 600,000 extra lives per annum.

Region	Approximate current population (millions)	Average survival rate per million population	Number of current survivors (thousands)	Potential lives saved per annum if the survival rate reaches 100 per million population (thousands)
HICs	1000	50	50	100
LMICs	6000	<5	<30	600
Total	7000		<80	700

The shared 2030 goal is to help save 150,000 extra lives from cardiac arrest every year. About 50,000 will be the lives of in-hospital patients (see next chapter), but the lion's share will be about 100,000 in the community: representing about 1/6th of the global potential. Based on recent data approximately 60% (i.e. 60,000) of this potential is likely to come from the first two links, 25% from the early responder link, and the balance from professional care.



Opposite page: Mr Ha, on track - now an enthusiastic and active supporter of CPR.

Mobilising the first resuscitation team

Over 70% of all witnessed community cardiac arrests occur in the home where there is most likely only one rescuer. But the rescuer is never alone if a telephone is near to hand – mobile phones are now ubiquitous – and professional help is given over the phone by the ambulance dispatcher to help recognise the cardiac emergency and guide the rescuer in performing CPR until a volunteer first responder or ambulance arrives. Such “telephone CPR” (T-CPR) can be very effective especially when the bystander has previously received some community CPR training including simulating interaction with the ambulance dispatcher.

Such a so-called first resuscitation team of bystander and dispatcher has been the key to recent success in Korea. It was in 2013 that Laerdal helped with dispatcher training in Seoul and the following year partnered with Seoul National University Hospital and Seoul Metropolitan Government to develop a complementary CPR training program. Called HEROS it prepared the bystander for interacting with the dispatcher. In the subsequent four years, survival rates increased by 50% from 29 per million population in 2014 to 44 per million in 2018.

Looking forward, the challenges and opportunities are on two fronts: increasing the number of people who receive community training in CPR and improving the quality and efficiency of such training; and maximising the interaction between the rescuer and the dispatcher to improve the quality of the CPR delivered to the casualty. Digital advances in training products and methodologies and the widespread use of mobile phones will open new opportunities for success. For example:

- enabling the dispatcher to monitor the rescuer’s performance and give feedback where needed;
- video assistance of the caller by the dispatcher – now in use in Denmark, Korea and Japan;
- use of Artificial Intelligence to assist the dispatcher - as video and audio data from the contact between rescuer and dispatcher becomes available, machine learning will be used to improve early recognition of the character of the emergency which is critical not only in cardiac arrest but also in cases of stroke and sepsis.

*Opposite page:
alone at home when her husband
collapses – and yet, thanks to the
dispatcher, part of an instant team.*





The Restart a Heart Day has grown from a European initiative to a world event.

On or around Oct 16 every year, citizens of all countries are mobilised to Learn CPR, often with “Kids save lives” as a common theme. Participation has been growing year by year, reaching over 1 million in 2019.

Improving community CPR training

Good data are scarce on the number of new CPR trainees added to the global pool each year; many include those who have been trained before and are having their skills refreshed. However, the number is probably about 10 million per annum in HICs. The next question to answer is: what does this need to increase by to achieve the shared goal? The best guess is that it would need to be about 10 times the current figure.

Based on data from Sweden and Denmark, it has been estimated that best-practice CPR coverage is achieved when 60% of the target population age 18-80 years are trained and are supported with T-CPR. This would equate globally to having a pool of about 3 billion trainees for maximum effect. To reach the shared goal of 60,000 extra lives saved in the first two links of the Chain of Survival (1/6th of the global potential) mentioned earlier would therefore equate to a pool of about 500 million new rescuers. That means an average of an additional 50 million trainees per annum over the next ten years, reaching a peak of about 100 million per annum.

Such a large increase in such a relatively short time will require a radical change in training methodology and delivery, which is more likely to happen in societies which are not wedded to current methods. And these new trainees will need to be concentrated in societies that are developing the other links in the Chain of Survival to achieve a high survival rate. These factors point to Asia as being a prime target, given initiatives such as HEROS (see page 34), PAROS - the Pan-Asian Resuscitation Outcomes Study, the formation of the Asian Association for EMS, and the activities of the Global Resuscitation Alliance in that continent (see page 44). That does not, however, decry the need for initiatives in well-developed systems. For example, a nationwide program for training school children has contributed, along with first responder defibrillation initiatives, to a remarkable increase in survival in Denmark over the last 10 years. And the British Heart Foundation’s Nation of Lifesavers program, started in the UK in 2014, has trained 5 million new lifesavers and reached 90% of UK secondary schools.

Four-fold increase in survival in Denmark

The Danish Cardiac Arrest Register was established in 2001 and it showed that only 4% of those that had a cardiac arrest in the community survived beyond 30 days of their arrest, just over 30 per million population. Recent results show that survival has increased four-fold to 16% - 140 per million population – now on a par with the best in the world, Seattle, USA.

This has been achieved following the principles that were the basis of the Seattle success and were embodied in the ten steps subsequently adopted by the Global Resuscitation Alliance.

Key actions included:

- Dispatcher assistance to the bystander.
- First aid training during driving lessons. This has been compulsory since 2006.
- First aid training in schools. This is also obligatory. And since 2006, the TrygFoundation has been distributing

manikin sets to schools free of charge and free training material has been available from the Danish Resuscitation Council.

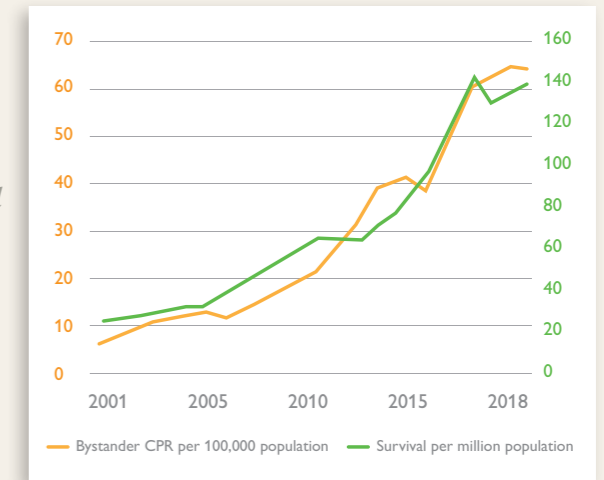
- Registration of volunteer first aiders willing and available to assist with CPR (and collect a defibrillator) if they are near a cardiac arrest incident. They receive an alarm from the dispatcher on their mobile phone directing them to the incident and identifying where the nearest defibrillator is located.

These actions have all contributed to an increase in bystander CPR from about 1 in 4 cases of sudden cardiac arrest in 2001 to 4 out of 5 cases in 2018. The graph shows how this increase correlates very closely with the increase in survival over that period.



“The Danish school CPR program has been a very important contributor to the four-fold increase in survival from prehospital cardiac arrest in Denmark.”

Freddy Lippert
Director of Copenhagen EMS Services



Current initiatives that can help increase the number of volunteers trained and improve CPR competence include:

- A complete classroom solution - using video-based instruction, data-driven real-time feedback, a cognitive quiz on smartphones and a gamified QCPR race to stimulate competition and quality improvement. There is also a data dashboard which helps such improvement: if a student struggles with a parameter, for example ventilation volume, the video and hands-on training are adjusted to help correct this.

With Bluetooth communication from each trainee's manikin to a tablet, one course facilitator can monitor and give feedback on the performance of up to 42 students. This is about 6 times the traditional facilitator:student ratio, and initial positive experience with such a system in Japan has resulted in a request on the possibility of increasing this ratio even further. It has been validated in Peking and Shanghai and is being rolled out in China as an integral part of the WeCan CPR training program.

- Greater inclusion of defibrillator training in CPR programs – to maximise the usage of Public Access Defibrillators (see next section) by the lay public. An example is the program in Shenzhen, China where the law requires 100 laypersons to be trained for each defibrillator installed in a public place.

Future initiatives could include more digitally-oriented home training solutions for those who typically do not go to CPR classes, including even simpler simulators than the innovative Mini Anne combined with online videos and VR simulations on smartphones. Improved school CPR training programs including e-learning and student instructors could also be beneficial.



Opposite page: gamified QCPR race with Bluetooth communication.



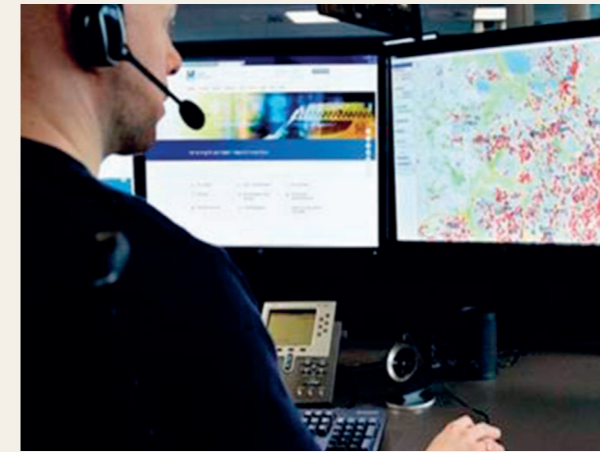
Activating a community of first responders

In addition to early CPR, the intervention shown to have a significant effect on survival from community cardiac arrest is early defibrillation. This has resulted in the placement over the last 20 years or so of a very large number, in excess of 5 million by industry estimates, of Automatic External Defibrillators (AEDs) in public places – so called Public Access Defibrillators. However, these defibrillators have been used on very few occasions considering the number in place - by some estimates in less than 1% of cardiac arrests. A literature review by researchers from Warwick University (UK) and the London Ambulance Service published in 2017 identified several barriers to their use including few people knowing what an AED is, where to find one, or how and by whom one can be used. Even amongst those who might find one and know how to use it, lack of confidence and fear of harm are common barriers to actual use.

Luqman's story

Muhammad Luqman Abdul Rahman of Singapore is only 18 years old and has already helped save nearly 20 lives. He was just 13 when he made his first save: on the way home from school his My Responder app from the Singapore Civil Defence Force alerted him that a factory worker had suffered a heart attack and collapsed close by. Having sprinted to the scene, Luqman performed CPR until the ambulance arrived – and later recalled that he had felt daunted because "actual doing was very, very different from practising."

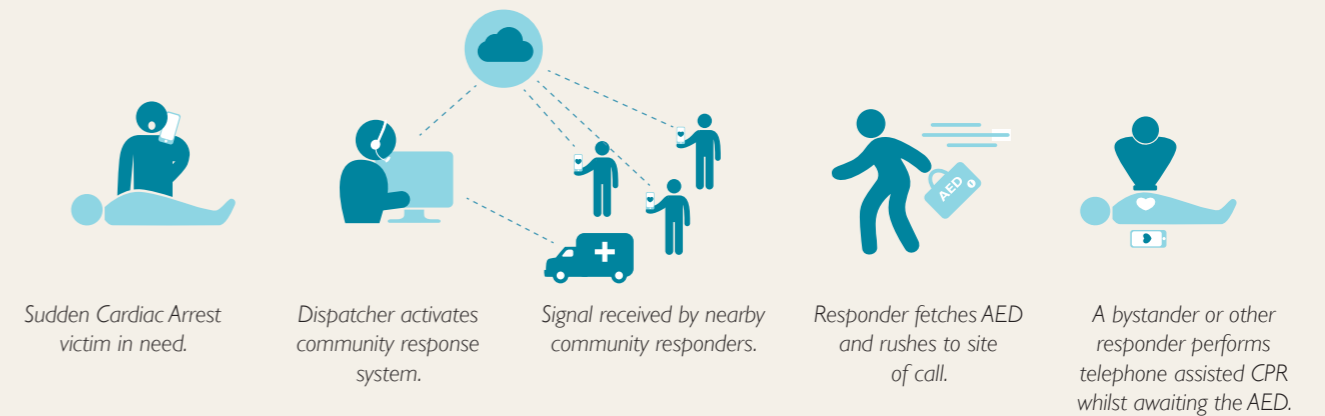
At first, Luqman's parents were against his responding, fearing that the boy would be blamed if something went wrong. Asking them to come along the next time the alert sounded, he won them over - and by now they must be the proudest parents in Singapore.



Dispatcher sees registered AEDs in the vicinity of the emergency.



Video-based communication between bystander and dispatcher.



To address this, in addition to the initiatives mentioned in the last section to increase training of the lay public, a number of EMS services have compiled registers of public access defibrillators in their community and are using mobile apps such as PulsePoint (USA), GoodSAM (UK and Australia), HeartRunner (Sweden, Denmark) and MyResponder (Singapore) to enrol those willing and able to respond to an emergency. When the EMS dispatcher receives a cardiac arrest call, they can activate the nearest first responders through the mobile app and give the location of the nearest AED.

In an impact evaluation of GoodSAM in Victoria, Australia, when GoodSAM responders arrived first they were on average nearly 2 minutes faster than dispatched paramedics – a significant time saving when early intervention is crucial. Survival in this group was 41% compared with 11% for those cases that GoodSAM responders did not attend. In Singapore there are now more than 70,000

responders and 20,000 AEDs registered in their system for a population of under 6 million. There, and in other cities where most of the population live in high-rise buildings, use of AEDs by janitors or security personnel has also proved effective.

The role of the first responder is also of course to provide early CPR – either to assist the bystander or initiate it. To improve and monitor the quality of this CPR, Singapore EMS have now provided the Laerdal CPR card to their first responders. The card gives real-time feedback to the rescuer on the quality of CPR. The latest version also includes Bluetooth. This can give improved feedback to the user on their mobile phone, but importantly it can also transmit through the phone the user performance in real time to the dispatcher to enable them to give verbal feedback where needed. It also facilitates post-event review and quality assurance of the system.

Tim's Story

Tim Hillier is Deputy Chief, Professional Standards at Medavie Health Services West, Saskatoon, Canada.

With 200 firefighters, primary care paramedics and EMTs, Tim and his team have fully embraced the need for high-quality CPR and real-time feedback.

"The way I look at it, I know that there are six more people alive in Saskatoon each year that wouldn't have been if we hadn't done this."

TeamReporter

To enable EMS and other healthcare professionals to practise High Performance CPR with their colleagues at a time of their choosing either in a classroom or in their workplace, Laerdal is developing the TeamReporter app. All they will need is a Laerdal QPR manikin to record the compression and ventilation data and a mobile phone to video the session.

At the end of the session the manikin data and video are uploaded to the Cloud for analysis. The team will then get detailed stats and a summary video of their performance for debriefing. Comparison of the stats with other peer groups adds a competitive element that has proved very popular with users and encouraged them to improve performance.

QCPR aids

The CPRcard is a personal device, to be carried around at all times, giving CPR performance guidance to the rescuer.

The CPRmeter is a high-intensity and re-usable system for professional health workers.



Opposite page: Tim Hillier.

High Performance EMS CPR

The quality of CPR delivered by the responding emergency team is also a very important predictor of survival. Such "High performance EMS CPR" is sometimes called the "dance of resuscitation", "the CPR ballet", or "pitstop approach". Like professional racing car pit crews, each team member should know exactly what to do with minimal waste of time and effort. The Resuscitation Academy in Seattle, USA, recommends that Quality Improvement (QI) programs should provide performance feedback to involved personnel after every cardiac arrest.

Digital downloads from CPR aids and defibrillators quantifying CPR performance now allow for such feedback on chest compression rate and in some cases compression depth, incomplete release, and time without compressions before and after a shock and when performing the advanced manoeuvres of intubation and IV access. Laerdal and the American Heart Association (AHA) are working with the Resuscitation Academy to develop a Resuscitation Quality Improvement program, RQI for EMS, based around the principle of Low-Dose, High-Frequency Training which has been validated in hospitals (see next chapter). This program will enable EMS personnel to refresh their CPR skills in short but frequent sessions on simulators positioned in their base station. An analytics program will help these skills to be tracked, and the TeamReporter app will help improve team performance.



EMS best practice going global

Following the success of the Resuscitation Academy started in King County, Seattle in 2008, a meeting of EMS international experts was held in 2015 in Utstein Abbey, near Stavanger, Norway, to address the challenge of spreading EMS best practice around the world. This led to the establishment a year later of the Global Resuscitation Alliance (GRA) charged with increasing survival from cardiac arrest by 50%. The GRA has since held workshops in Korea, Japan, Singapore, China, Australia, Norway, Sweden, Denmark, Switzerland, the UK and, to address the challenges in LMICs, in India.

Although the approach taken by the GRA is centred around the well-established Chain of Survival, it is now evident that to maximise the impact of the links in the Chain they need to be embedded in a framework of strong leadership, systematic refresher training, and a quality improvement system that drives a culture of excellence. This is now being referred to as the Frame of Survival and underpins the GRA approach enumerated in its 10 steps to improve survival.

There are now 76 case studies on the GRA website (<https://www.globalresuscitationalliance.org>) covering these ten steps. Several of them have already been mentioned earlier in this chapter regarding community CPR training, telephone CPR, first responder AED programs, and ensuring High Performance CPR by EMS personnel.

All this said, the first step to improving survival is data collection i.e. Establishing a Cardiac Registry – knowing how well the system is doing and monitoring progress is fundamental. Measure to Improve should be the mantra of all systems. There are 13 GRA case studies relating to data collection, one of which details impressive increases in survival across several systems which have had such registries for many years (see graph opposite).

Best Practice to Improve Cardiac Arrest Survival

- 1 Cardiac arrest registry
- 2 Telephone CPR for more and better CPR
- 3 High performance EMS CPR
- 4 Rapid dispatch
- 5 CPR performance data
- 6 First responder AED programs
- 7 Smart technologies to expand CPR and Public Access Defibrillation
- 8 CPR/AED training in schools and the community
- 9 Accountability
- 10 Work towards a culture of excellence

A beacon for all

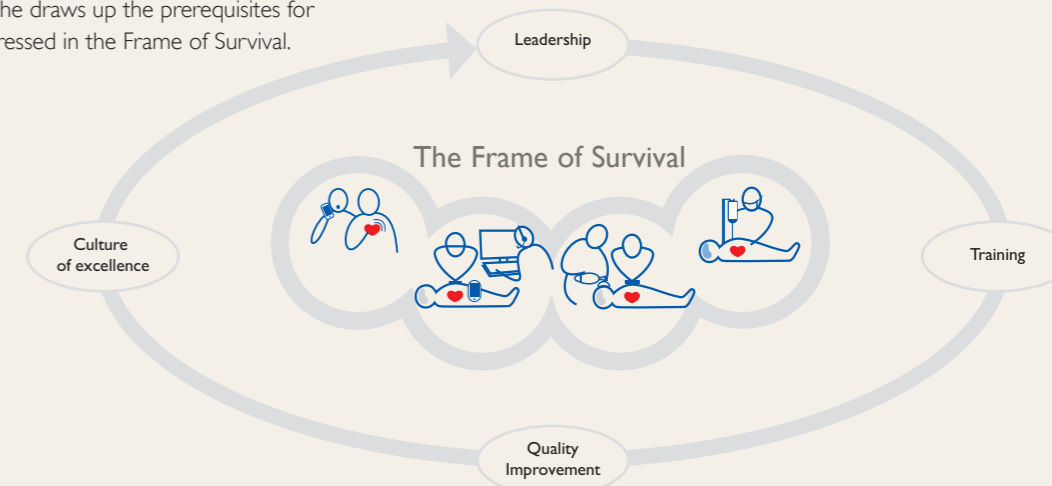
Mickey Eisenberg has been, and remains, an untiring pioneer in lifesaving of worldwide importance. Under his leadership King County, Seattle has been a beacon for everyone with survival rates for witnessed cases with a shockable rhythm – the Utstein benchmark - exceeding 50%.

The research conducted with his colleagues in the Center for Evaluation of Emergency Medical Services has been crucial for identifying what works best and has been the basis for many updates of international guidelines. The basic principles are set out in his book "Resuscitate! How Your Community Can Improve Survival from Sudden Cardiac Arrest" and are being spread to communities across the world through the GRA.

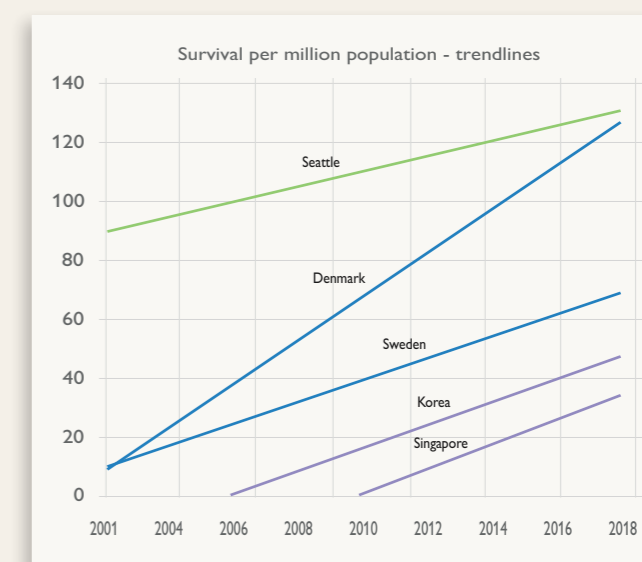
Mickey strongly believes the success is down to collaboration, expressing his appreciation to professionals who helped make Seattle a world leader: "the hundreds of emergency dispatchers, the thousands of EMTs, and the hundreds of paramedics." In his book, he draws up the prerequisites for developing a culture expressed in the Frame of Survival.



Mickey Eisenberg - EMS pioneer



The graph compares trends in survival from community cardiac arrest expressed in number of survivors per million population from 2001 through to 2018 in several countries with the results from Seattle. It shows that substantial increases in survival can be achieved by following the best practices of the GRA of which EMS systems in these countries are members. The results from Denmark are particularly noteworthy and have been described earlier in this chapter.

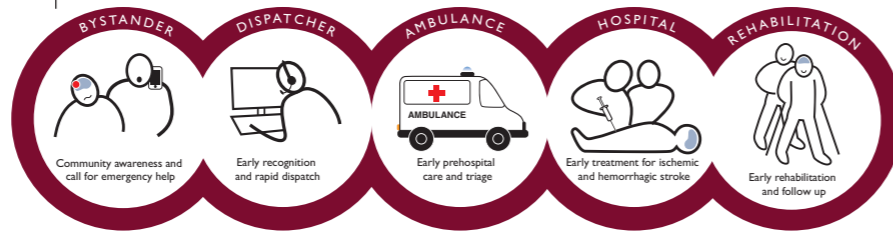


Stroke

According to the Global Burden of Disease statistics, there were 5.5 million deaths from stroke in 2016, 39% in the under 70s. There are over 13.7 million new strokes each year and 80 million people currently living who have experienced a stroke. And over 116 million years of healthy life are lost each year due to stroke-related death and disabilities: 63% in those under the age of 70. So, stroke does not just strike the elderly - a common misconception. Approximately 2 million brain neurons are damaged for each minute that it is left untreated. This does not sound a lot bearing in mind that we each have about 100 billion neurons in our brains. But if those damaged are in critical areas of the brain, even a small injury can be devastating

A devastating duo

They share an initial and the same number of letters, and they devastate the lives of millions, but that is not all they have in common. For both stroke and sepsis, time is of the essence. Early recognition with the help of an emergency dispatcher, a well-trained ambulance crew, rapid transport to a properly resourced centre, and early intervention by a well-trained hospital team are critical for both survival and quality of life. This is illustrated in the stroke equivalent of the cardiac arrest Chain of Survival, established at an Utstein meeting in 2018.



Sepsis

Sepsis is an overcharged response of the body to infection which injures its own tissues and organs. Recent data from the Global Burden of Disease study published in the *Lancet* indicate that it affected almost 50m people worldwide in 2017 with 11m sepsis-related deaths. This is more than double previous estimates, with babies and small children in poorer countries at greatest risk. The leap in deaths comes from an attempt to quantify what is happening in LMICs from where data were previously underrepresented: the *Lancet* study is the first to produce global estimates across 195 countries.

Public campaigns have been widely employed to improve the recognition of the symptoms of a stroke and sepsis, but more can be done. For example, live-video streaming from the home to the emergency dispatcher coupled with improved training and Artificial Intelligence could help in rapid diagnosis. If there are serious delays in recognition, then subsequent attempts by health-care personnel to save the patient from death or serious disability may be futile. This said, though, a very rapid response when the patient arrives at the hospital is essential.

Delay of call and EMS recognition of emergency

	Incidences	% deaths	Deaths	Typical delay to call EMS*	Typical accuracy of dispatcher recognition*
Sudden cardiac arrest	5m	98%	5m	1min	75-85%
Stroke	15m	33%	5m	30min	60-65%
Sepsis	30m	33%	11m	30min	50-60%
Accident	100m	5%	5m	1min	98%

*These estimates are for HICs. The situation is very much worse in LMICs.



In the case of stroke, it is essential to determine whether it is caused by a clot or bleeding in the brain before medical treatment begins. If a clot is present it needs to be dissolved quickly with a drug (trombolysis), but if bleeding is occurring such a drug will make matters worse. A brain scan is essential to differentiate between the two, and a well-drilled team involving emergency physicians, radiologists and surgeons is the key to successful treatment.

The measure of the quality of treatment in such cases is what is called “door to needle time (DNT)”: the period from when the patient enters the hospital to when they receive thrombolysis. The AHA/American Stroke Association guideline - typical of global standards - is that the average DNT should be under 60 minutes. High-fidelity simulation can prepare the team to deal with the emergency and help reduce this time as described in the next chapter.

Training in teams for faster diagnosis and more efficient treatment of sepsis and stroke.



The World Health Organization comes to Utstein

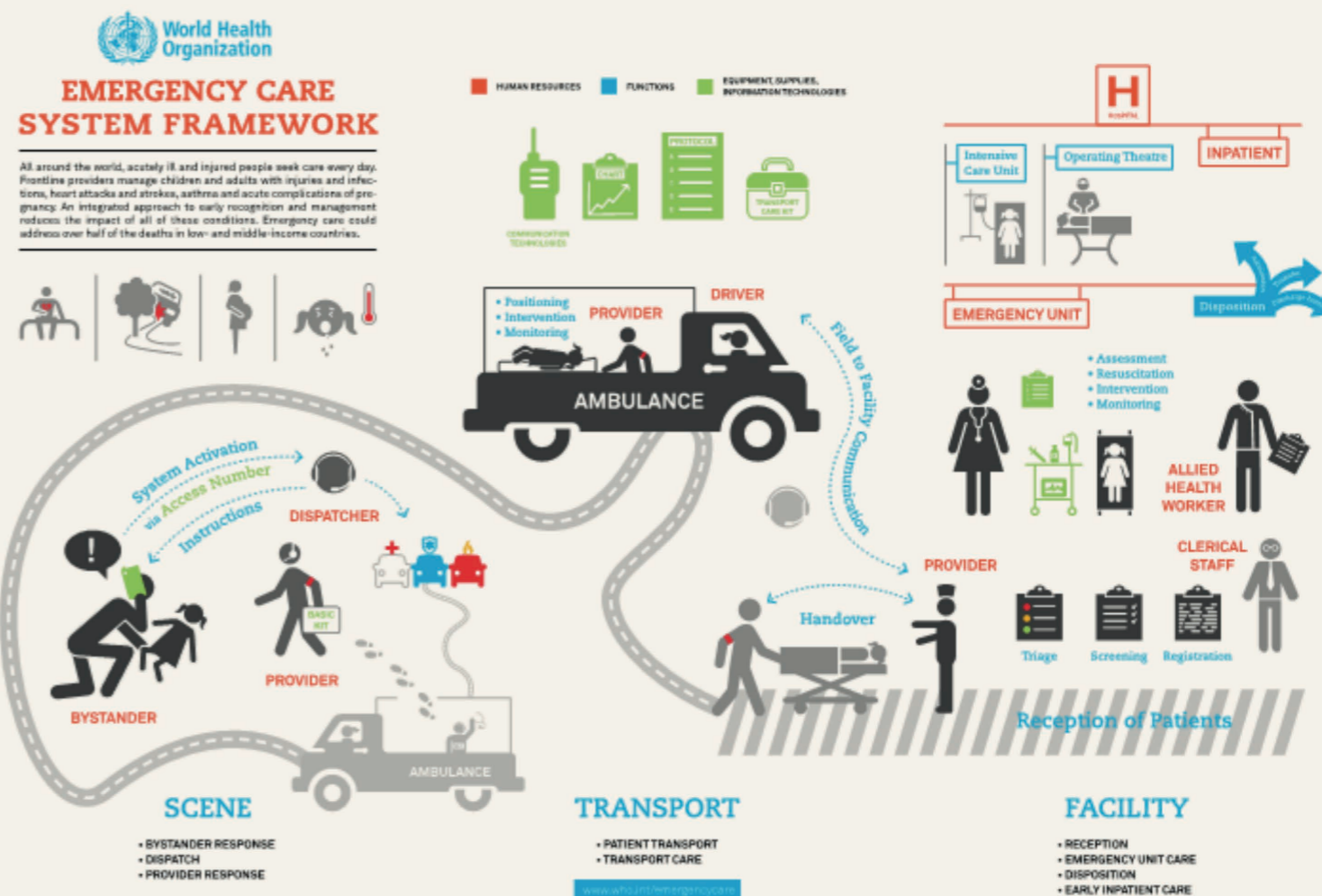
The World Health Organization (WHO) has defined a series of essential functions for an Emergency Care System that spans from pre-hospital care – including the role of the bystander and the dispatcher - and transport through facility-based emergency unit care to early operative and critical care.

In the 2018 World Bank Monograph, Disease Control Priorities: Improving Health and Reducing Poverty, Teri Reynolds, head of the Emergency, Trauma and Acute Care program at the WHO, along with co-authors, set out key policy strategies for strengthening national healthcare systems globally to provide emergency care more effectively. Although most of the evidence for system improvements comes from HICs, the authors concluded that “such improvements can also be made - affordably, sustainably, and with dramatic impact – in LMICs”. As one of the follow-ups to this report, the Laerdal Foundation and the WHO, represented by Teri and her team, are organising an expert meeting on Strengthening Emergency Care Systems at Utstein Abbey outside Stavanger, Norway. This historic site has hosted more than 25 expert meetings supported by the Laerdal Foundation which have led to landmark recommendations for evaluation and reporting on various aspects of emergency medicine and education.

“By a resolution in May 2019, the World Health Assembly has called on Member States and WHO to prioritise action to strengthen Emergency Care Systems for Universal Health Coverage.”



Teri Reynolds
Scientist, World Health Organization



Emergency care for 10 SDG targets

- 3.1 Maternal mortality: treatment of obstetric emergencies, including pregnancy-related bleeding.
- 3.2 Under-five mortality: treatment of acute diarrhoea and pneumonia, the top killers of children.
- 3.3 Deaths from malaria and other diseases: treatment of acute infections and sepsis.
- 3.4 Reduce mortality from NCDs: treatment of heart attacks, strokes, and other acute exacerbations of NCDs.
- 3.5 Strengthen treatment of substance abuse: treatment of overdose and other complications.
- 3.6 Halve road traffic deaths and serious injuries by 2020: post-crash emergency care.
- 3.8 Achieve Universal Healthcare Coverage: emergency care is an essential component.
- 3.9 Deaths and illnesses from hazardous chemicals: treatment of acute exposures.
- 11.5 Deaths caused by disasters: preparedness and response to save lives and mitigate system collapse.
- 16.1 Violence-related deaths: treatment for victims of violence.

Ashley's Story

Newly out of residency, Ashley van der Zee Ormsby RN, BSN, had no idea late one evening that she would be relying on her simulation training to ensure a patient's very survival. The patient, just after emergency surgery, suffered a pulmonary embolism that sent him into cardiac arrest.

Crediting an identical case in her simulation training at Children's Hospital, Washington State University, Ashley called a code, took the lead, and directed the delivery of CPR for 30 minutes. The patient survived.

Opposite page: Ashley van der Zee Ormsby
Photo: Washington State University
College of Nursing

Quality care in hospital

The preceding chapter has addressed the quality of health care provided in the community by EMS personnel. Here we look at how the quality of care provided by healthcare professionals in the hospital setting can be improved.

A *Lancet* report in 2018 estimated that 8.6 million deaths per year in 137 low and middle-income countries (LMICs) were due to inadequate access to good-quality health care: 5.0 million were estimated to be due to poor-quality care and 3.6 million to non-utilisation of health care. This dismal scenario is far from applying only to less well-off economies: after the US Institute of Medicine landmark report in 1999, *To Err is Human*, estimated that medical errors in US hospitals might be causing up to 100,000 unnecessary deaths each year, healthcare quality has increasingly come into focus. And a 2016 study published in the *British Medical Journal* throws an even bigger spotlight on the issue: extrapolation from studies published since 1999 suggests that the figure exceeds 250,000, making medical error the third most common cause of death in the US.

Such poor-quality care is generally attributed to either poor initial training or failure to maintain and improve competencies of healthcare workers. However, having insufficient staff in a healthcare facility is felt by many to be also a significant factor.



The Patient Safety Movement

The Patient Safety Movement (PSM) Foundation was established in 2012 with a mission to reduce preventable deaths in hospitals from medical errors to zero by 2020, by working with all stakeholders to address the problems with actionable solutions. Although the goal has not been reached on this timescale, the Foundation still believes that it is the right goal and can be achieved with the right people, ideas and technology. It has focussed minds on the issue and resulted in the establishment of eighteen Actionable Patient Safety Solutions including on neonatal safety, optimal resuscitation, airway safety, and obstetric safety. Close to 5,000 hospitals worldwide and 100 professional societies, associations, and healthcare-related organisations have partnered with the PSM to help reach the goal. In 2018, Laerdal committed to contributing to the PSM goal by helping save 25,000 more lives that year through simulation-based educational programs. Including – with its partner the American Heart Association - 5,000 more lives through the Resuscitation Quality Improvement Program. Laerdal Global Health has committed to contribute 30,000 extra lives every year towards the PSM goal through programs described in the next chapter.

Improving access

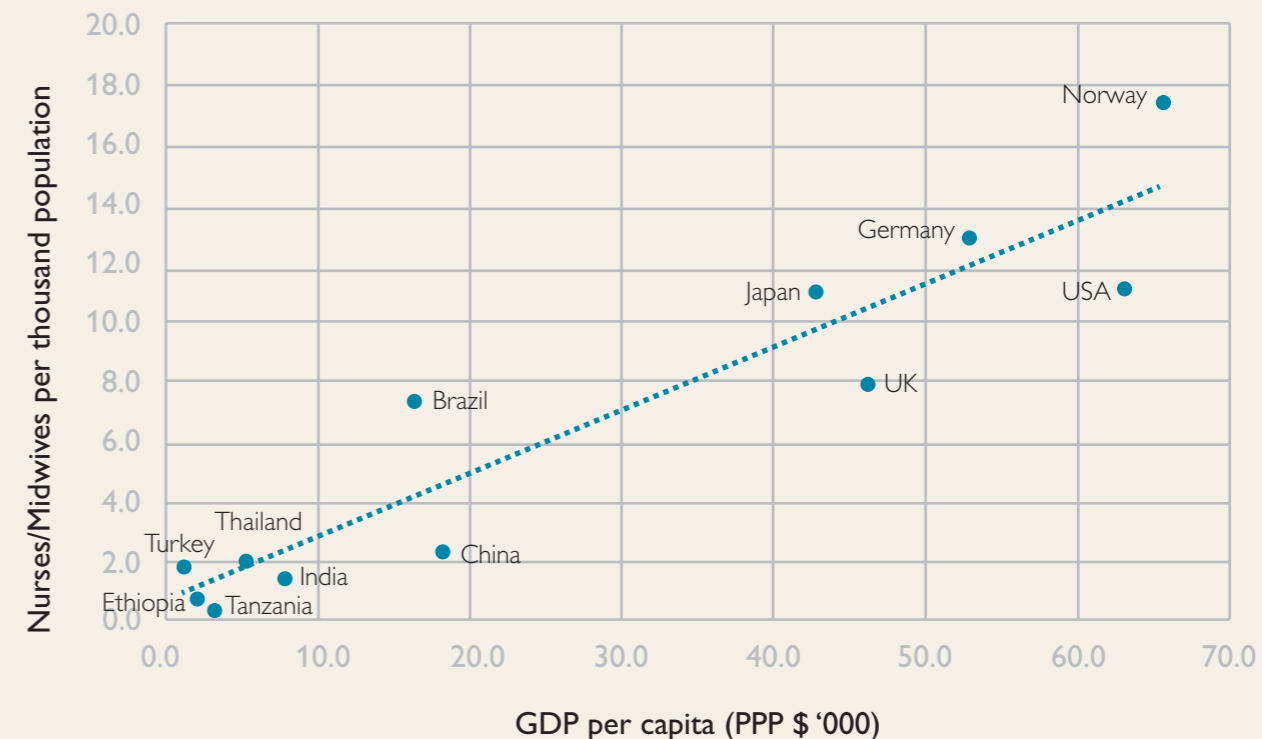
In 2016 the UN High Level Commission on Health Employment and Economic Growth issued its report and recommendations to the UN Secretary General, Ban Ki-moon, on the investments and actions needed to make progress towards achieving the SDG3 goal of Universal Health Coverage including access to quality essential healthcare services.

It estimated that without action there will be a shortfall, primarily in LMICs, of 18 million health workers needed to achieve and sustain Universal Health Coverage. But the UN report may have underestimated the shortfall by not considering fully the aspirations of healthcare systems in LMICs to go beyond minimum standards. This may also have been the case when the WHO estimated that there were 21 million nurses/midwives worldwide with a global shortfall of 9 million.

64 million reasons to change

The global shortage of nurses - no matter how skilled the others are - impacts quality of care. And there is an enormous disparity between HICs and LMICs regarding the numbers of nurses and midwives ranging from 18 per 1000 population in Norway to less than 1 per 1000 population in Ethiopia and Tanzania. For LMICs to get close to the HIC average of about 10 per 1000 by 2030 would require - with a projected global population of 8.5 billion - a global pool of about 85 million nurses and midwives, an increase of 64 million over the current estimate of 21 million. A seemingly impossible task. It just would not be affordable for LMICs if existing practices were followed. There is, unsurprisingly, a strong linear relationship between the number of nurses and the wealth of a country (see chart). A similar relationship applies for doctors. Waiting for countries to grow richer is not an option: economic growth of 3% per annum would only increase the global nursing pool by 35% over 10 years.

So how can the nurse shortages be addressed? Simply focussing on numbers entering nurse training is clearly not enough. The policy solutions must look to increasing productivity, for example through task shifting to assistants and the use of community health workers. And use of emerging technologies can play a big part as identified in the UN High Level Commission Report. The impact that technologies can have has been amply demonstrated in the field of personal communications with mobile phones now almost as common in China and India as in HICs. A similar revolution is needed in health care.



Sources: World Bank/OECD



The transformative potential of e-learning

E-learning enables education and training to become more learner centred, interprofessional, outcome- and practice-focussed, workplace-based, equitable, collaborative across education and training providers, and scalable at greater efficiency without compromising effectiveness. E-learning can accelerate the development of the right skills at the required scale to achieve universal health coverage and respond to emerging disease threats. A global consortium of over 50 researchers and experts is conducting 12 systematic reviews. Preliminary findings suggest that e-learning is at least as effective as traditional forms of education for health professionals; and that, for example, serious gaming or gamification interventions and virtual reality environments have significant potential advantages over traditional methods in knowledge and skills acquisition. Further studies with more robust methodologies are required to determine the impact of e-learning on learning outcomes.

Working for Health and Growth. Investing in the Health Workforce. High-Level Commission on Health Employment and Economic Growth. World Health Organization 2016

Crossing the digital divide

The UN Commission's recommendations towards addressing the healthworker shortfall include:

- harnessing the power of cost-effective information and communication technologies to enhance health education, people-centred health services and health information systems;
- scaling up transformative, high-quality education and lifelong learning so that all health workers have skills that match the health needs of populations and can work to their full potential.

The Commission goes on to point out that technologies can be transformative if the digital divide - the uneven distribution across countries of access to Information and Communication Technologies (ICT) - can be crossed. But they must be properly resourced, regulated and in line with country ethics, principles and values. Opportunities mentioned include telemedicine, e-learning (see sidebar), electronic health (e-health) and mobile health (m-health), social media, massive open online courses, webcasts, podcasts, high-fidelity simulation, decision-support tools, electronic medical records, electronic systems for disease surveillance, civil registration and vital statistics, and laboratory and pharmacy information systems. These technologies can broaden the reach of health systems, even in the face of health worker shortages in remote and inaccessible areas. They can also strengthen collaborative teamwork and accountability and facilitate people-centred approaches to care.

The obstacles compromising technology's full potential to remedy the health workforce gap and improve health services include: lack of proper evaluation of what works and what does not (an obstacle to moving from pilots to full-scale implementation), lack of internet access and ICT infrastructure, costs of connectivity, lack of electricity supply, data insecurity, and restrictive regulatory frameworks. Other challenges include lack of ICT and digital technology knowledge and resistance to change among educators, health system managers and health workers. Reaping the benefits of rapidly changing technologies will require internet/ ICT infrastructure investments, especially in low- and middle-income countries.

An excellent example of how technology can transform health-care delivery is the competence-based revolution in resuscitation from cardiac arrest.





American Heart Association

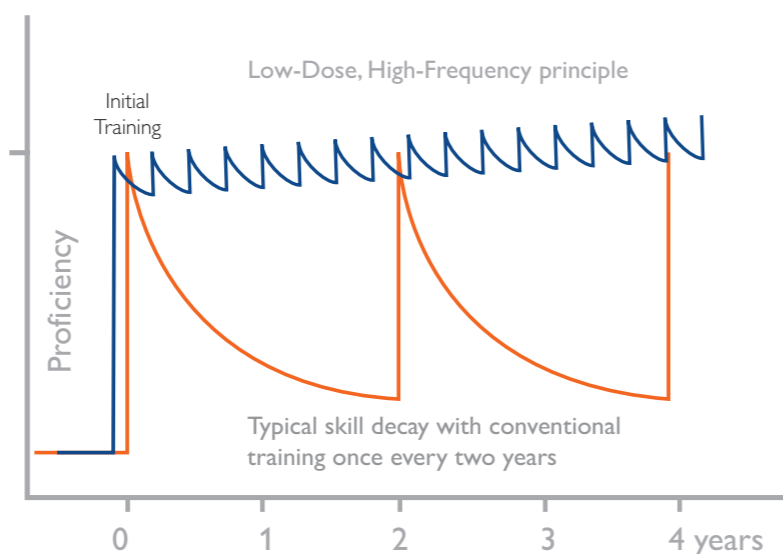
A long-standing partnership

Laerdal and the American Heart Association (AHA) have worked together for close to 50 years.

It was in 1974 that Laerdal supported the publication and distribution of the AHA's first "Standards and Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiac Care." In 1997, a vital alliance was formed between the two organisations leading to the development of the HeartCode e-learning program and the MIniAnne kit for CPR training in schools and the community. In 2014 they introduced together the Resuscitation Quality Improvement (RQI) program to US hospitals. This program was based around the so-called Low-Dose, High-Frequency (LDHF) principle, moving health care away from big-dose, infrequent training to focussing on continuous improvement of competence.

The competence-based revolution

Research in the early 2010s had shown that the usual practice of two-year intervals between refreshing skills in both basic and advanced life support was inadequate because such skills often deteriorate within three to six months. Instead, allowing each healthcare worker to refresh skills every three months in a 10-minute session at a moment of their choosing at a skills testing station at their workplace was shown to be not only effective at counteracting skill decay but greatly improved skill performance over time. It also reduced the cost of refresher training for the hospital, avoiding the need to send people out for a course and fill in with replacement staff, and was also more convenient for both the hospital and healthcare worker. But most important, quality of care improved. As a result, at one of the early adopters, Texas Health Presbyterian Hospital in Dallas, survival doubled in the first year.



"This is probably the most exciting and important project that has come up in the AHA in the last twenty years, and it may be so also for the next ten years."

Nancy Brown
CEO, American Heart Association



Opposite page:
LDHF session to confirm RQI eCredential.



An American Heart Association® and Laerdal® Program

Catrina's story

Catrina Brown was heading home from Texas Health Harris Methodist Hospital, South Worth, after a long day's work, when she saw a motorcyclist had crashed and was lying unconscious by the side of the road. Another bystander called 911 and Catrina performed chest compressions until the ambulance arrived.

As a postpartum nurse, Catrina hadn't performed CPR in years. She credits the regular training she receives through the RQI program at Texas Health for keeping her skills fresh.

"It really works," she said. "When I came back to work, I told people two things: wear a helmet, and pay attention to CPR training."

RQI partners

In June 2018, after the initial success of the Resuscitation Quality Improvement program (RQI), the AHA/Laerdal relationship grew even closer with the objective of rolling out the program across all hospitals, starting in the US. The best way to achieve this was felt to be the formation of a separate company, RQI Partners, owned jointly by the AHA and Laerdal with personnel from both organisations dedicated exclusively to the goal of helping save 50,000 lives every year. After less than two years of operation, RQI Partners is well on the way to achieving this goal with 20% of US hospitals having adopted RQI as their program of excellence in resuscitation.

The cognitive part of RQI uses the e-learning component of the AHA-Laerdal HeartCode program, which breaks down the curriculum into bite-size learning activities each quarter. In place of the two-year "course completion card", the program has taken a big step forward by issuing an "e-Credential" verifying that the participant is competent in resuscitation skills.

The RQI eCredential

Healthcare providers who have verified their competence through active and ongoing participation in the RQI program are issued with an RQI eCredential card. This represents that the individual has achieved the gold standard exceeding any prior requirements for resuscitation training.



Opposite page: Catrina Brown
Photo: Texas Health Resources

At your service

Laerdal offers its Simulation as a Service program to the US healthcare companies, HealthTrust and Audacia, as part of their educational packages for healthcare institutions. Simulators and task trainers, a technician to run them, and a facilitator to assist the clinical educator are part of the service.

The Health Trust program focusses on bringing new nurses on board for medical, surgery and obstetrics, and transitioning registered nurses to ICU and ED. 7,000 nurses have been through their simulation program to date.

With the Nursing Anne simulator, Audacia delivers their HERUSA program covering heart failure, respiratory, urinary, sepsis and anemia.

Simulation as a Service has also proved popular in the UK and Australia where it has been recently introduced.

High-Fidelity Simulation

The benefits of quality improvement go beyond resuscitation to other hospital emergencies where patient safety is a serious concern such as trauma, sepsis, stroke and pediatric, neonatal and obstetric care. A well-drilled team is crucial - and this is where high-fidelity simulation comes to the fore using patient simulators with highly realistic and variable features to mimic as closely as possible various emergency scenarios.

In 2015, the US National Council of State Boards of Nursing recommended that high-fidelity simulation could gainfully substitute up to 50% of clinical practice across the nursing curriculum. And in 2017 the medical journal *JAMA* published a review and meta-analysis of simulation use in training health professionals. The authors listed best practice points for optimal effectiveness: facilitated debriefing, in situ refresher training, distributed practice, curriculum integration, clinical variation, range of difficulty, individualised learning, multiple learning strategies, defined outcomes, and valid simulator.

Whilst most institutions accept that simulation has a significant role to play in both education and refresher training of doctors and nurses, they may lack the capital to purchase simulators, the technicians to maintain them, or the faculty to run the programs. In some cases, all three. Laerdal's Simulation as a Service program is intended to help such institutions.

Also, the advances in video capture and data processing increase substantially the feedback that can be provided to trainees on their performance during not only simulation practice but also in the clinical environment to help close the circle between training and therapy. The leading provider of such services, B-line Medical, has now joined the Laerdal group of companies.

“Sim-based training has brought a new dimension to medical education in the last decade.”

Doris Østergaard

Director of Copenhagen Academy for Medical Education and Simulation (CAMES)



Seeing is believing

What do you get when an aerospace engineer joins up with a computer technologist? Initially something quite mundane albeit useful, but something truly innovative and potentially lifesaving quickly emerges and then matures into what today allows the collection and streaming of live video into the Cloud opening the way for analysis with deep machine learning. Technology designed to provide feedback to human learners to improve both the quality of their education and continuous quality improvement of the delivery of care in the patient environment.

It was in 2003 that Lucas Huang, who worked on the Hubble Space Telescope for NASA, met up with Chafic Kazoun, a technology leader at a consulting company called B-Line Express (as in the shortest distance between two points) in Washington DC, USA. In 2004, they were asked to build a custom solution for facilitating OSCEs (objective structured clinical examinations) - the type of examination used to test clinical skill performance and competence. The solution had to be 100% web-based and as reliable as the paper-based exams. They were tasked with automating data and video capture, assessment, and all associated reporting and tracking. They both wanted to create great products and together

started a new company called B-Line Medical and their first product, Clinical Skills, was born.

Over the next 14 years, B-Line Medical grew from a small start-up with three US medical school clients to become the world's leading provider of video-driven healthcare education solutions for both simulated and live clinical care environments.

Thanks to a smart dedicated team committed to the mission, B-Line Medical has secured an impressive and loyal clientele that now consists of over 500 hospitals, medical schools and nursing programs throughout the world. Clients in its home country include Mayo Clinic, Children's Hospital of Philadelphia, Boston Children's Hospital, Cleveland Clinic, Stanford University, Johns Hopkins University, Harvard University, and Yale University. In 2018, B-Line Medical launched the new SimCapture Cloud Platform, a game changer for healthcare simulation that offers a fully cloud-based software platform with a remarkably small onsite audio-visual footprint and affordable subscription pricing. And in 2019 it joined the Laerdal family of companies with a shared goal of helping improve healthcare quality.



A long and evolving partnership

The American Academy of Pediatrics (AAP), an organisation of over 67,000 child health providers, was amongst the early adopters of simulation-based training when their Neonatal Resuscitation Program (NRP) Steering Committee decided in 2007 to transition future education program initiatives to this methodology. The result was SimNewB.

The collaboration around the NRP program led AAP to invite Laerdal to the NRP Global Implementation task force in 2009. This brought about the Helping Babies Breathe program and the establishment of Laerdal Global Health, as described in the next chapter:

The success of the collaboration motivated the partners to address needs in other AAP life support programs leading to co-development of Pediatric Life Support Scenarios, and Pediatric Education for pre-hospital personnel with the SimJunior pediatric simulator (representing a 6-year old), and Premature Anne. Several self-directed programs followed including Simply NRP for parents and other family members, and an e-learning component for the NRP program.

This long partnership is still evolving with application of low-dose, high-frequency training to improve baby and infant programs.

Opposite page: SimNewB, one of several newborn simulators developed in collaboration with representatives of the AAP newborn resuscitation committee.

Improving the care of mothers and babies

Maternal and infant mortality has been reduced significantly over the last few years but there is room for further improvement. Saving the lives of mothers and babies in low-resource settings will be addressed in the next chapter. Here, the focus will be on what can be done in high-resource settings – there is room for improvement there as well. For example, although the USA spends 18% of its national income on health care, its maternal mortality rate has more than doubled from 10.3 per 100,000 live births in 1991 to 23.8 in 2014: over 700 deaths per annum, and of these, two thirds are preventable.

In the first decade of this millennium, Laerdal introduced its first high-fidelity infant and newborn simulators, SimBaby and SimNewB. These were developed in close collaboration with the AHA and the American Academy of Pediatrics (AAP) for their respective Pediatric Advanced Life Support (PALS) course and Neonatal Resuscitation Program (NRP). The collaboration with the AAP led to the development of the 25-week old premature baby simulator, Premature Anne. When introduced in 2016, this was the first high-fidelity simulator for premature babies, focussing on improving the airway management skills that are critical to saving these tiny lives.

Substantial efforts have recently gone into developing second generation versions of both SimBaby and SimNewB to bring their features up to date with the latest needs. Highly realistic airways and external appearance, user feedback, and wireless operation improve the learning experience. SimBaby Tracheostomy has also been introduced to train parents and caregivers of children with compromised airways.

Over the last decade, Laerdal has worked with the UK Bristol-based company, Limbs & Things, to develop the SimMom birthing simulator. This evolved from combining two products – Laerdal's ALS Simulator and Limbs & Things' PROMPT birthing simulator – providing users with both anatomical accuracy and authentic simulation of emergencies such as post-partum haemorrhage, uterine inversion, and maternal collapse.

“The Helping Babies Breathe program has helped save tens of thousands of newborns from birth asphyxia.”

Janna Patterson

SVP, Global Child Health & Life Support
at American Academy of Pediatrics





National League
for Nursing

The International Year of the Nurse and Midwife

2020 has been designated by the World Health Organization (WHO) as the International Year of the Nurse and the Midwife. The WHO recognises that nurses and midwives play a vital role in providing health services. These are the people who devote their lives to caring for mothers and children giving lifesaving immunisations and health advice, looking after older people, and generally meeting everyday essential health needs. They are often the first and only point of care in their communities. The world needs 9 million more nurses and midwives if it is to achieve universal health coverage in accordance with SDG3 by 2030.



Opposite page and above:
Nursing Anne Simulator. Exchangeable
parts allow it to be used for training in
the care of patients of varying ages and
ethnicity.

From the classroom to the bedside

Doctors and nurses are commonly expected to step straight from school into practice with little subsequent attention to improving skills.

The shortcomings in training programs for “onboarding” new nurses have been glaring: a US study showed that 75% of new nurses were observed to commit medical errors. Nurses who lack confidence are more likely to leave their jobs – and in the US 34% of new nurses do so by the end of their second year. Replacing them is costly and patient safety is affected by this high attrition. To address this, in 2015 the US National League for Nursing (NLN) and Laerdal developed the Education Solution for Nursing program.

“The impact goal is better patient care, but the program will also significantly reduce cost for the employer.”

Beverly Malone

CEO of National League of Nursing



That same year, the NLN collaborated with the Ministry of Education in China to develop a multi-year plan for introducing simulation-based education in several hundred nursing schools. Also, in 2019 a Memorandum of Understanding was established between Laerdal Medical India, SAFER simulation centre in Stavanger, and the India Nursing Council to join forces to introduce simulation-based training initially in 2,500 of the nursing schools in India.

Another interesting dimension is inter-professional education. Students rarely have the chance to train with other professions, but the day they start working they are expected to work in teams in critical situations. Simulation training can help prepare them, improve their confidence and close the transition gap. Digital self-directed learning can significantly reduce the time required for campus and clinical training, supplemented by teamwork on patient cases and peer-to-peer learning. This process is an impressive cost cutter: whereas the faculty student ratio has traditionally been 1:3, the ratio for peer-to-peer simulation is 1:18. A comprehensive package of scenarios is now available for nursing schools.





Safe anaesthesia and surgery

According to the Lancet Commission on Global Surgery, five billion people – two thirds of the global population – lack access to safe and affordable anaesthesia and surgery. Clinical conditions requiring surgical, obstetric, and anaesthesia services amount to 30% of the global disease burden; however, surgical care remains the most neglected area of global health with less than 1% of global health funding.

Laerdal is a global Impact Partner of the World Federation of Societies of Anaesthesiologists (WFSA). The Laerdal Foundation awarded a grant to the WFSA to introduce in 2017-18 its Safer Anaesthesia from Education (SAFE) program in Tanzania, Bangladesh, Nepal, and Zambia. The success of this initiative - with 320 anaesthesia providers trained - led to the Foundation providing further funding for WFSA to scale up implementation in India and Tanzania. This second phase also includes the VAST program in which WFSA is trialling new educational approaches including team-based simulation training in selected health facilities.

The Foundation has also supported a consensus meeting on metrics and reporting criteria for improving patient safety during surgery, obstetrics, and anaesthesia held at the Utstein Abbey, outside Stavanger, Norway. The participants concluded that the same evidence-based rigor and consensus that has been at the core of other Utstein topics such as out-of-hospital cardiac arrest is crucial.

“Two thirds of the global population lack access to safe and affordable anaesthesia and surgery. WFSA is committed to change this situation.”



Jannicke Mellin-Olsen
WFSA President



Opposite page:
a challenging setting for safe anaesthesia.

A shining example

It was in 2005 that SAFER, the Stavanger Acute medicine Foundation for Education and Research, was founded around a simulation centre in a collaboration between Stavanger University Hospital (SUS), the University of Stavanger and Laerdal. During its first 15 years it has made great progress in meeting its prime goal to improve patient safety and strengthen competence among health workers. By 2020, over 250 facilitators are active in running more than 50 educational programs at the centre.

SAFER's original purpose was to serve the needs of its founding partners. Indeed, it has proved an invaluable resource for SUS. In 2018 alone, there were over 45,000 hours of simulation training of SUS healthcare personnel - 27,000 at SAFER, 18,000 in the hospital itself. SUS now leads the league table for quality care in Norway. Its approach to healthcare quality improvement has simulation training at its core for a range of time critical emergencies. One example of this excellence is its approach to dealing with the victims of stroke. A revised treatment protocol in combination with on-site simulation-based team training sessions brought the time from entering the hospital to treatment down to a remarkable average of 13 minutes compared with the generally accepted standard of under 60 minutes.

This successful program with SUS has enhanced SAFER's standing throughout Norway leading to a request from the Norwegian health authorities for SAFER to assume the role of the national center of excellence in simulation.

Its research activities have gained scope and momentum, with a steady stream of PhDs and over 100 peer-reviewed publications. It has played a key role, and continues to do so, in the Safer Births research program with Haydom Lutheran hospital in rural Tanzania described in the next chapter.

Moreover, the roll-out of SAFER's educational methodologies has started in South East Asia and several African countries. For example, in India, SAFER and Laerdal are implementing a cascade model for simulation training targeted at the 550 medical and 6000 nursing schools in the country in partnership with the Indian Nursing Council and SGT University in Delhi.



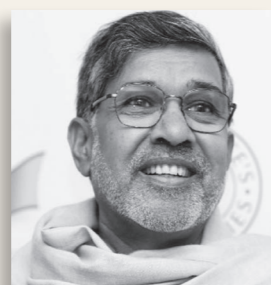
Elsa Søyland, Executive Director of SAFER, leads a simulation session.





India: The seeds have been planted

The sub-continent of India has close to 20% of the world's population and is the world's fifth largest economy. But it only spends about 3.7% of its national income on health care including private expenditure equating to \$300 per person compared with the \$6,000 that Norway spends per inhabitant. This difference in expenditure is reflected in the comparative numbers of nurses per thousand population – 1.4 in India vs 17.5 in Norway. But things are changing quickly. Over the last five years, India had the world's fastest growing economy. Half of its population is under 25 years of age and India has the greatest number of software developers – exceeding 5 million. This will have a huge impact on its ability to deliver solutions that benefit the health of the population.



“India may be a land of over hundred problems, but it is also a place for a billion solutions.”

Kailash Satyarthi
Nobel Peace Laureate 2014

Laerdal's involvement in India has also developed considerably over the last decade. Until then its products were sold through distributors in small quantities not tailored for local needs. The first Laerdal seed was planted in India in 2010 when Laerdal Medical India was established in Chennai with a small sales organisation, followed by Laerdal Global Health (LGH) setting up a small R&D team in Pune. With this closeness to the users, LGH was able to develop a product that met the needs of babies to survive and thrive – an innovative low cost preterm wrap worn by the mother to keep her baby warm by skin-to-skin contact even whilst working. In 2016, LGH joined with Laerdal Medical India and opened offices in New Delhi and then Mumbai with a total staff now of 40. Partnerships followed with the Indian Nursing Council, Jhpiego and SGT University in Delhi to open the first National Reference Simulation Centre for Nursing in India; and with several medical and nursing universities promoting simulation-based education.

In 2017 a team of software engineers was established in Bangalore – the software capital of India – out of a co-operation with an established local software company, Impelsys. Laerdal Bangalore has since grown to about 200 developers with 35 directly employed by Laerdal, the others being a flexible resource from Impelsys. In addition to working on projects with other Laerdal companies, they have developed a new platform for the 2020 version of the Resuscitation Quality Improvement program of the AHA-Laerdal joint venture, RQI Partners.

Opposite page and above:
advanced programs for nurse training
in India.





Enhancing vaccination

On June 4th, 2020, Laerdal and Gavi, the global vaccine alliance, announced a new partnership to enhance and monitor frontline healthcare worker vaccination performance using innovative educational and digital technologies.

Gavi was formed in 2000 as the Global Alliance for Vaccines and Immunization and has since helped vaccinate nearly 800 million children and save more than 13 million lives. But it is estimated that 1.5 million children still die each year due to causes that could have been prevented if they were vaccinated. Gavi spends over \$ 100m each year on training frontline health professionals and implementing vaccine programs in low-resource countries, but despite these investments there is limited evidence of the impact on healthcare worker performance.

Having taken note of the contributions of Laerdal Global Health to the Helping Babies Survive programs and the collaboration with the Global Finance Facility, Gavi invited Laerdal's assistance to make its training and quality assurance solutions more effective. This will be achieved through simulation training and skills management, with digital solutions capturing data for quality assurance and needs-based refresher training. This overlaps a lot with solutions Laerdal has already made and wishes to develop further including the Safer Births and RQI programs.

Responding to the pandemic

As this book goes to press the world is in the middle of a pandemic of the new coronaviral disease, COVID-19. Although the disease has passed its peak in some countries, in others, especially in South Asia, Africa and South America, weekly cases and deaths are still increasing. LMICs now account for three-quarters of the 100,000 plus new cases per day. On current trends, deaths in cases where the presence of the virus has been confirmed will exceed 600,000 by end July, but this is almost certainly a significant underestimate of the impact because of underreporting, underdiagnosis and "indirect" deaths due to patients being unwilling to seek medical treatment during the pandemic for emergencies such as cardiac arrest and stroke. The true figure may well exceed one million.

Many countries went into lockdowns to limit the spread of the disease, but as they come out of these lockdowns there are concerns about subsequent waves of the disease. These are likely unless effective vaccines are developed, or the virus disappears naturally. For "herd immunity" to be achieved, it will be necessary to vaccinate billions of people. Gavi, the global vaccine alliance, is committed to helping make this happen and has partnered with Laerdal to make its training and quality assurance solutions more effective.

The economic impact of the lockdowns has been severe with many companies having to lay-off large numbers of staff. For Laerdal, its traditional training products have been seriously affected with classroom activities suspended, but this has been partially offset by a greater demand for respiratory therapy and training products. Also, the company's RQI and e-learning solutions have proven beneficial to customers to limit social contact. Complimentary scenarios were developed very rapidly to assist healthcare personnel, especially those returning to clinical practice, in preparing for and dealing with COVID-19 patients. Given the severe effect of the coronavirus on the lungs of some patients, the ASL 5000 Lung Solution from Laerdal's partner, Ingmar Medical, used in conjunction with its patient simulators and free training scenarios, has proved very valuable.

In the absence of face-to-face contact, webinars have been organised to assist users in implementing the new scenarios, and on May 28th Laerdal hosted the first virtual Simulation User Network Conference. Over 3000 participants from 80 countries had presentations from experts from Stavanger, Copenhagen, London and New York on their experiences using simulation to address the challenges of COVID-19.



Developing an Emergency Ventilator in record time

In the early phases of the pandemic in March 2020, there was a great concern that healthcare facilities would be overwhelmed and there would be insufficient ventilators for treating seriously ill patients. Several countries, including Norway, put out requests for companies to fast-track development and manufacture of emergency ventilators. Laerdal and Servi AS, another Norwegian company, responded to the request and with advice from clinical experts at Stavanger University Hospital, Oslo University and the Norwegian Armed Forces developed in record time an emergency ventilator based around a specification drawn up by the UK Department of Health. The system incorporates the widely-used Laerdal Silicone Resuscitator with O₂ reservoir system, a peep valve adjustable from 5 – 20 cm H₂O, a pressure relief valve and alarm, and a heat and moisture exchange filter. It includes a mechanical arm and high-quality motor and control electronics to compress the resuscitator bag and deliver accurately the required volume of oxygen at the appropriate rate.

The device has been designed for simple and safe operation to facilitate its use by the new categories of healthcare personnel that it was thought would be required, and may still be required in some countries, for assisting in the treatment of a growing number of COVID-19 patients. Together with the SAFER simulation centre in Stavanger, Laerdal also developed a specific training program.

Following recommendations from the clinical experts, the Norwegian health authorities placed an order for 1,000 units for deployment in hospitals throughout the country by June 1st. This effectively doubled the number of available ventilators in Norway.

As it turned out, actions taken in Norway to control the spread of the disease meant that the initial capacity of intensive care beds and ventilators was enough to meet the need. However, the ventilators remain available in the event of a second wave of the disease or for countries in greater need.

The ventilator has a lower production cost than traditional intensive care ventilators. Laerdal and Servi expect that further industrialization and higher-scale manufacture will make it more affordable for low-and middle-income countries where the pandemic has not yet reached its peak.



Regina's story

Regina's baby did not breathe when it was born, but Monica Tippe, one of the most experienced midwives in Haydom Lutheran hospital in rural Tanzania, immediately started resuscitation, helping the baby survive. When the baby was brought to the Neonatal Unit, Mama Regina started bleeding heavily because the placenta was not complete when it emerged. Midwife Monica manually removed the remains and stopped the haemorrhage.

Saving lives at birth in low-resource settings

Helping save 500,000 more newborns a year by 2030 and preventing 50,000 more maternal deaths account for more than half of the One Million Lives goal. Worldwide, nearly 3 million newborn deaths and 1.3 million fresh stillbirths occur each year, 99% of them in low- and middle-income countries (LMICs). This chapter relates to the needs and initiatives in LMICs, but the initiatives can also feed into making births in high-income countries safer.

Birth-related complications cost about 200,000 maternal lives each year. In most of these cases simple procedures will suffice to save both mother and baby - if the birth attendant is well trained and confident. Early detection and treatment of complications greatly improve the chances of a good outcome.

SDG3 on health and well-being for all is more holistic than the previous health MDGs. With every life saved there is a significant amount of life years saved. Estimating that each saved baby will live for 70 years and each mother for 50, achieving the goal of saving 550,000 mothers and newborns means nearly 40 million life years gained – that is not counting the cases of prevented disablement.

As the shift progresses from donorship to ownership - the means of providing aid to enable governments and people to help themselves - partnerships are becoming increasingly important and are the bedrock of Laerdal's approach to helping improve global health.

Opposite page: Regina and her baby.



Laerdal Global Health is born

The story behind the One Million Lives goal starts in 2010, when Laerdal established the not-for-profit sister company, Laerdal Global Health (LGH), and became a dedicated member of the Helping Babies Breathe Global Development Alliance established by USAID.

Some years before, in 2007, the American Academy of Pediatrics (AAP) invited Laerdal to collaborate on developing a much-simplified and culturally-adapted course in newborn resuscitation to meet the needs in low-resource settings. Laerdal responded by providing educational design for the course that was to become widely known as Helping Babies Breathe (HBB) and the low-cost simulator, NeoNatalie, to make the training more engaging and effective. Lifesaving equipment, the Penguin Suction and the Upright Resuscitator, also became available as part of the program. When presented in 2008, the project elicited much enthusiasm. Testing in India, Kenya and Tanzania yielded ground-breaking knowledge: the HBB program was born.

Since then, large-scale studies that evaluated HBB programs in Tanzania and Nepal showed a 47% reduction in early 24-hour neonatal mortality and a 24% reduction in fresh stillbirths. This spurred further motivation to bring these innovations to scale.



More and more Happy Birthdays

Tanzania, Ethiopia and Rwanda have achieved wide-scale implementation of the Helping Mothers and Babies Survive programs through the 50,000 Happy Birthdays program. This 2018 - 2020 project was implemented by the national midwifery associations and the International Confederation of Midwives (ICM). It used a cascade model for facility-based training with ongoing continuous refresher training both in-service and pre-service.

The idea was launched in 2014 when, together with Laerdal and ICM, the midwifery associations in Malawi and Zambia set off the pilot 10,000 Happy Birthdays program in their countries, where maternal mortality was amongst the highest in the world. The project educated close to 10,000 birth attendants – the idea being that each trained attendant would help save at least one extra life every year.

Guiding the way forward

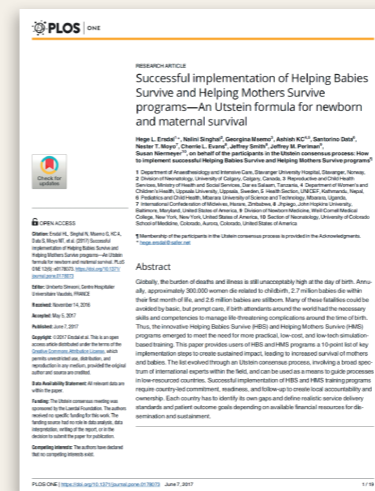
In 2017, an evaluation of the Survive & Thrive alliance (see next page) concluded that the following key achievements had been made:



Key Achievements

- Developed an evidence-based transformative training methodology for maternal and newborn care.
- Demonstrated that quality improvement approaches are essential to sustain quality care.
- Transformed the global landscape for basic newborn resuscitation.
- Increased access to lifesaving resuscitation and training equipment.
- Integrated Helping Babies Survive and Helping Mothers Survive into 30 national programs.
- Demonstrated that strong professional associations are a pathway to sustainability.
- Mobilized \$120m in contributions from all partners, 45% of which was in cash.

An Utstein meeting in June 2015 established best practice principles for implementation of the Helping Mothers and Babies Survive programs.



Best Practices Implementation of Helping Mothers and Babies Survive programs

1. Secure Ministry of Health buy-in.
2. Form a working group for planning, training, and monitoring.
3. Develop national roll-out plan for pre-service and in-service training in both public and private sector.
4. Provide learning materials and equipment at time of training.
5. Identify and support local leaders and champions.
6. Establish low-dose, high-frequency refresher training.
7. Establish facility-level Quality Improvement teams.
8. Collect and report local data on standardised indicators.
9. Establish a system for reporting and feedback.
10. Engage healthcare providers, families, and the broader community.

Helping babies and mothers survive

The tremendous interest that HBB raised triggered the obvious question: if hundreds of thousands of birth attendants could be reached by this course, would this be opportunity to also train them to prevent the number one killer of mothers, uncontrolled bleeding after birth?

Laerdal teamed up with Jhpiego, an affiliate of Johns Hopkins University, the leading NGO for maternal care. This inspired the development of the birthing simulator MamaNatalie as well as the Helping Mothers Survive (HMS) program.

With inclusion of the HMS program, the HBB alliance developed into the Survive & Thrive public-private partnership,

“The HBB GDA has demonstrated that public-private partnerships, driven by a shared goal and vision, can be a highly effective strategy for health development.”

Lily Kak
Sr Advisor for Global Partnerships
and Newborn Health at USAID



including professional associations, the private sector, NGOs and others. Although the formal partnership ended in 2017, its educational programs are reaching more than 100,000 new birth attendants every year by being embedded in national programs and through initiatives such as 50,000 Happy Birthdays.

Together with its partners, LGH has developed 25 products and programs over the company’s first ten years. These products are provided on a not-for-profit basis to the countries with the highest maternal and newborn mortality, and have reached more than 750,000 birth attendants.

“The Helping Mothers Survive program is already in use in over 50 low-resource countries.”

Cherrie Evans
Senior Technical Advisor, Jhpiego



Antenatal Care



Pre-eclampsia & Eclampsia addresses the second leading cause of maternal mortality.

Labour Management



Threatened Preterm Birth focusses on identifying women likely to deliver a preterm baby and the actions that can be taken prior to birth.



Essential Care for Labour & Birth and Complicated Labour & Birth focusses on how to ensure what starts out as a normal birth remains normal.

Birth



Helping Babies Breathe teaches the initial steps of neonatal resuscitation to save lives and how to give a much better start to many babies who struggle to breathe at birth.

Postpartum Care



Bleeding after Birth teaches active management of the third stage of labour, and early detection and basic management in order to reduce maternal deaths caused by postpartum haemorrhage.

Newborn Care



Essential Care for Every Baby Essential Care for Small Babies teach essential newborn care practices to keep all babies healthy from the time of birth to discharge from the healthcare facility.

Strengthening midwifery education

The Helping Mothers and Babies Survive programs have been shown to be very effective, providing an introduction to simulation for in-service training. Through the 10,000 and 50,000 Happy Birthdays programs they have also been successfully introduced to pre-service education. Laerdal, together with SAFER, the Stavanger Acute medicine Foundation for Education and Research, has worked with local partners in Nepal and India to strengthen midwifery education by integrating simulation into the curricula, educating faculty and setting up simulation labs. As many students leave school with very little practical and hands-on experience, this becomes a critical part of building the capacity of the health workers from day one.

“A happy birthday is a live and happy mother, a live and healthy baby, and a happy and excited family with a positive experience.”



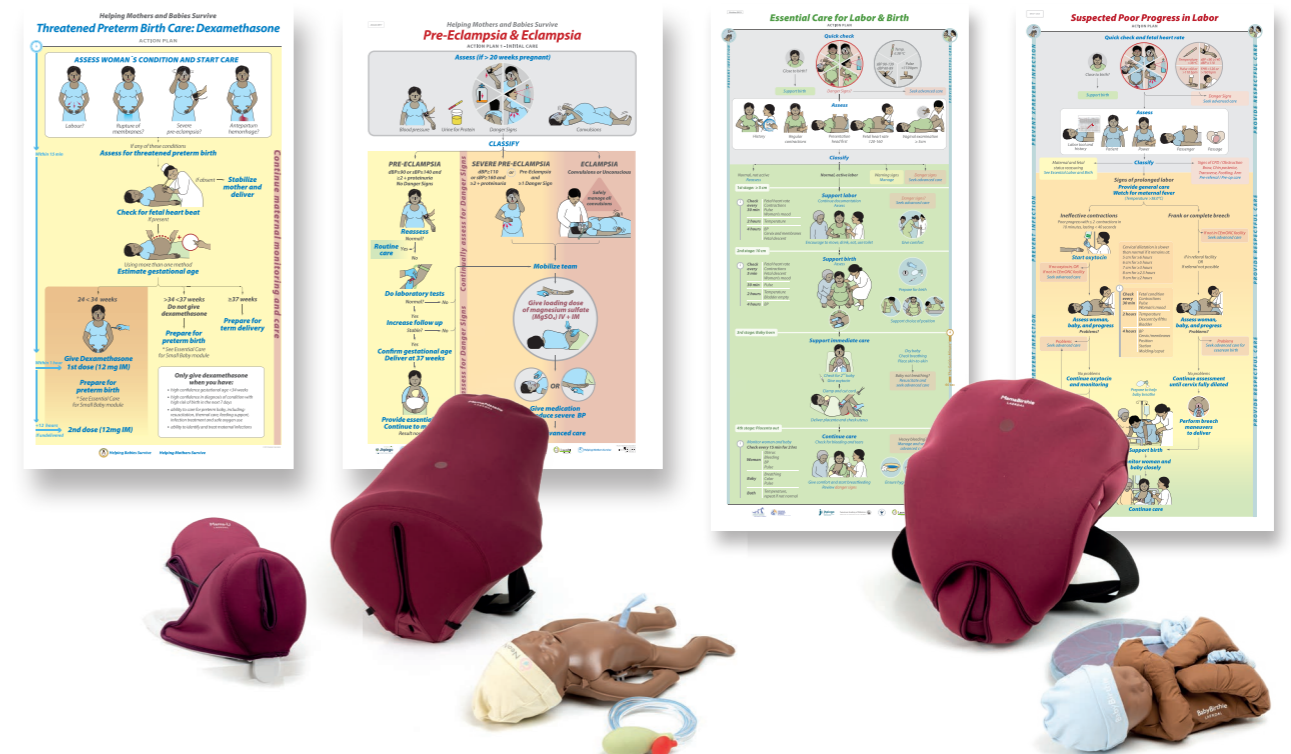
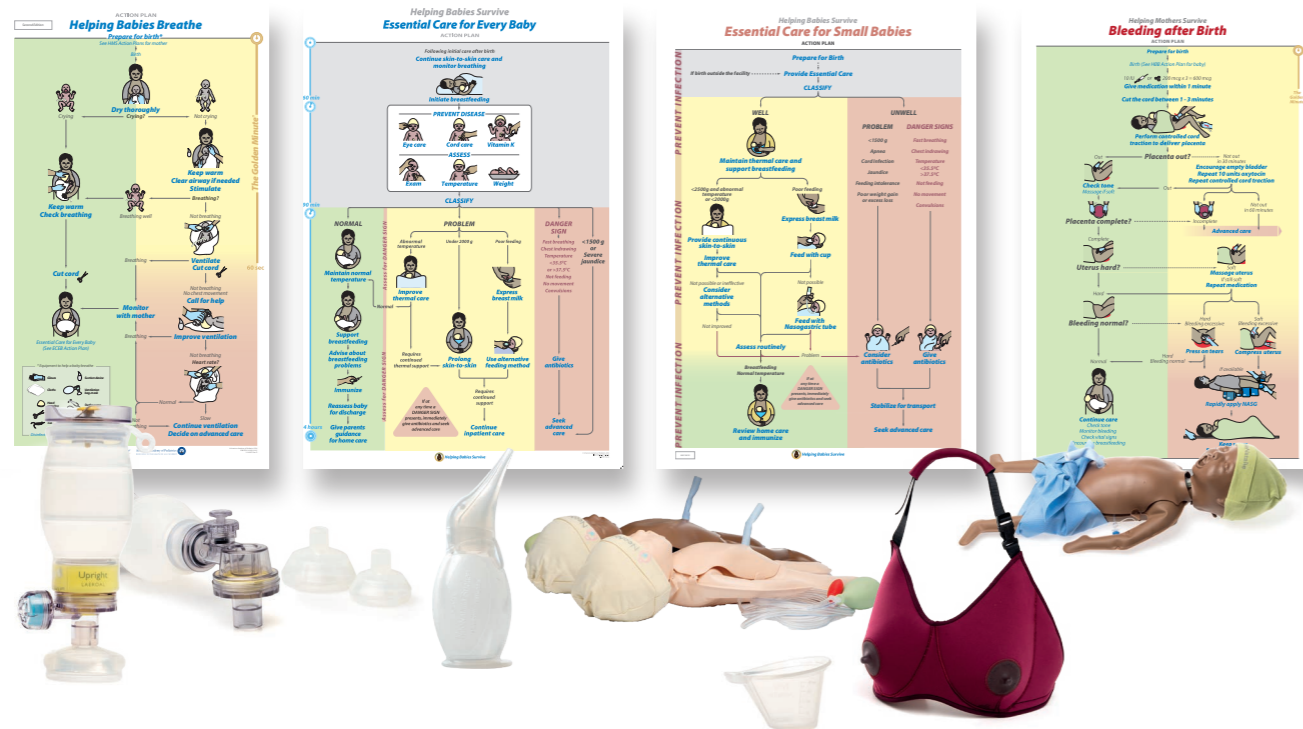
Sally Pairman
CEO, International Confederation of Midwives

Scaling up Kangaroo Mother Care to help small babies

Every year, 1 million preterm babies die, accounting for 35% of all neonatal mortality. Kangaroo Mother Care (KMC) includes skin-to-skin contact, breastfeeding and infection control, and remains a low-hanging fruit to improve survival of small newborns. Although the intervention is considered simple, the world has yet to implement it to scale and reap the benefits.

The Essential Care for Small Babies Program, together with the PremieNatalie and MamaBreast simulators, was developed with the AAP to provide training on how to effectively implement and support KMC. The Nifty Feeding Cup and the Care Plus preterm wrap were designed to support mothers caring for small babies.

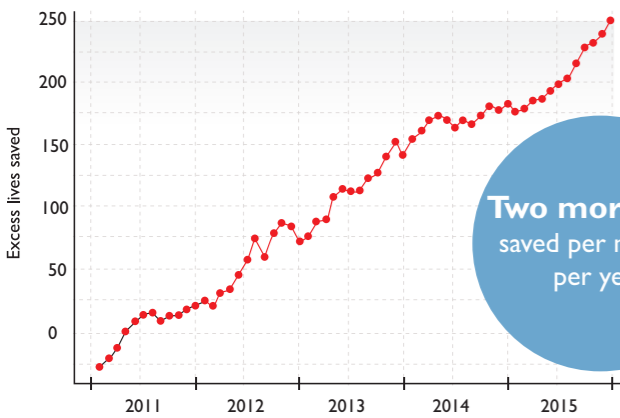
While the training programs focus on the initiation of care at the healthcare facilities, survival and growth of small babies depend on continuing KMC in the community by family members. “Saving Little Lives at Birth”, a winning proposal in the Innovation-to-Scale initiative of the Global Finance Facility, aims to increase the coverage from 5 to 80 per cent within a three-year time frame in four regions of Ethiopia.



Increasing the reach

Complementing the mother and baby programs, the Laerdal Foundation has supported the Global Health Media Project, which has developed 90 videos that cover small baby care, newborn care, breastfeeding and childbirth. Available in 30 languages, they have over 90 million online views. A future focus for Laerdal is to develop digital solutions that support quality scale up and low-dose, high-frequency training tailored for the needs of the providers and the facility.

Together with AAP and WHO, the Helping Babies Survive program has been integrated with the WHO Essential Newborn Care program, with all materials and support tools available in a digital format.



27,000 Safer Births studied

Haydom Lutheran Hospital in rural Tanzania was one of the Helping Babies Breathe research sites, leading up to the the ground-breaking “Safer Births” project. Led by Hege Ersdal of Stavanger and Estomih Mduma of Tanzania, by end 2019 the continuously growing team for research, innovation, and implementation had sparked twenty PhDs, completed or in progress - seven from Tanzania.

More than 100 people have been involved in the project, forming the basis for developing research and knowledge that were transformed into lifesaving medical devices in the hands of Tanzanian midwives. Observations and collected data from over 27,000 consecutive deliveries and 1,700 resuscitation cases make this the largest study on newborn resuscitation.


“We have very good knowledge about what is best to do, but this is useless if people don’t know what to do. Most research projects concentrate on just one of the elements in the Utstein


“The patient data gathered in Haydom represent an unparalleled source for research.”

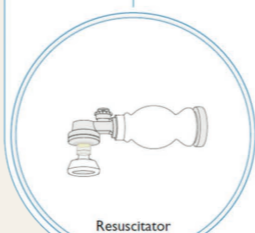
Jeffrey Perlman
Professor of Paediatrics,
Weill Cornell Medicine, New York

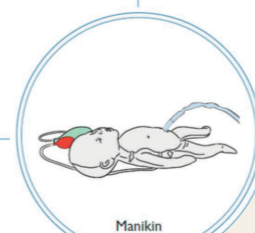



Current Birth Bundle
Safer Births Bundle

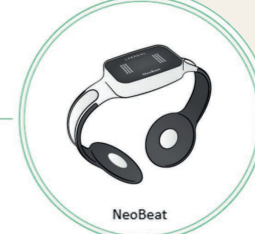

Pinard

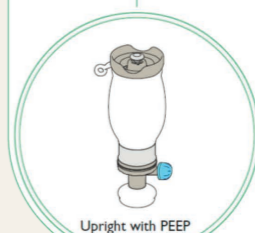

Stethoscope

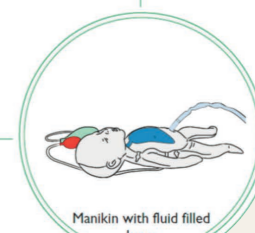

Resuscitator


Manikin


Moyo


NeoBeat


Upright with PEEP


Manikin with fluid filled lungs

The Safer Births Bundle

The implementation of HBB in Tanzania and the collaborative Safer Births research stimulated the development of the Safer Births Bundle. This consists of groundbreaking fetal and newborn heart rate monitors, an improved bag and mask, and a “smart” training manikin with varying lung and heart rate functions that provide feedback to the learner and facility.

The researchers and healthcare workers in Haydom and Muhimbili hospitals were instrumental in developing these innovations. All innovations have proved effective, efficient, and lifesaving. Almost 70 papers have been published in high-impact peer-reviewed international journals, evaluating and describing the bundle.

formula of survival: medical science, educational efficiency, or local implementation. We now have 10 years’ experience in looking at all the elements, and we are confident that we can propose a Safer Births package that makes a difference in knowledge, innovation, educational efficiency, and local implementation,” says Hege Ersdal, Principal Investigator, Safer Births.

Safer Births in Nepal and DR Congo

In Nepal, Grand Challenges Canada supported Golden Community to implement a scaleup project of the Safer Births bundle coupled with HBB and a quality improvement system in eight high-delivery hospitals covering 100,000 deliveries a year. The goal is to reduce perinatal mortality by 25%.

In DR Congo, the AAP received a Saving Lives at Birth Grand Challenges award to pilot in three hospitals the NeoBeat Newborn Heart Rate Monitor with an adapted HBB algorithm.

Safer Births scale up

The Safer Births research team will play an integral role in supporting the scale up of the Safer Births Bundle throughout Tanzania. This scale up is made possible by a grant from the Global Financing Facility (GFF), a sub-division of the World Bank, in an Innovation-to-Scale initiative (see next chapter).

Data-driven quality improvement

Digital technologies are playing a major role in Safer Births: affordable solutions developed on a basis of research are rapidly replacing conventional technologies as they help improve systems and programs and accelerate implementation.

“Based on the encouraging results at the Haydom hospital, the Safer Births Bundle will now be implemented at 30 district hospitals in Tanzania.”



Hege Ersdal
Principal Investigator, Safer Births

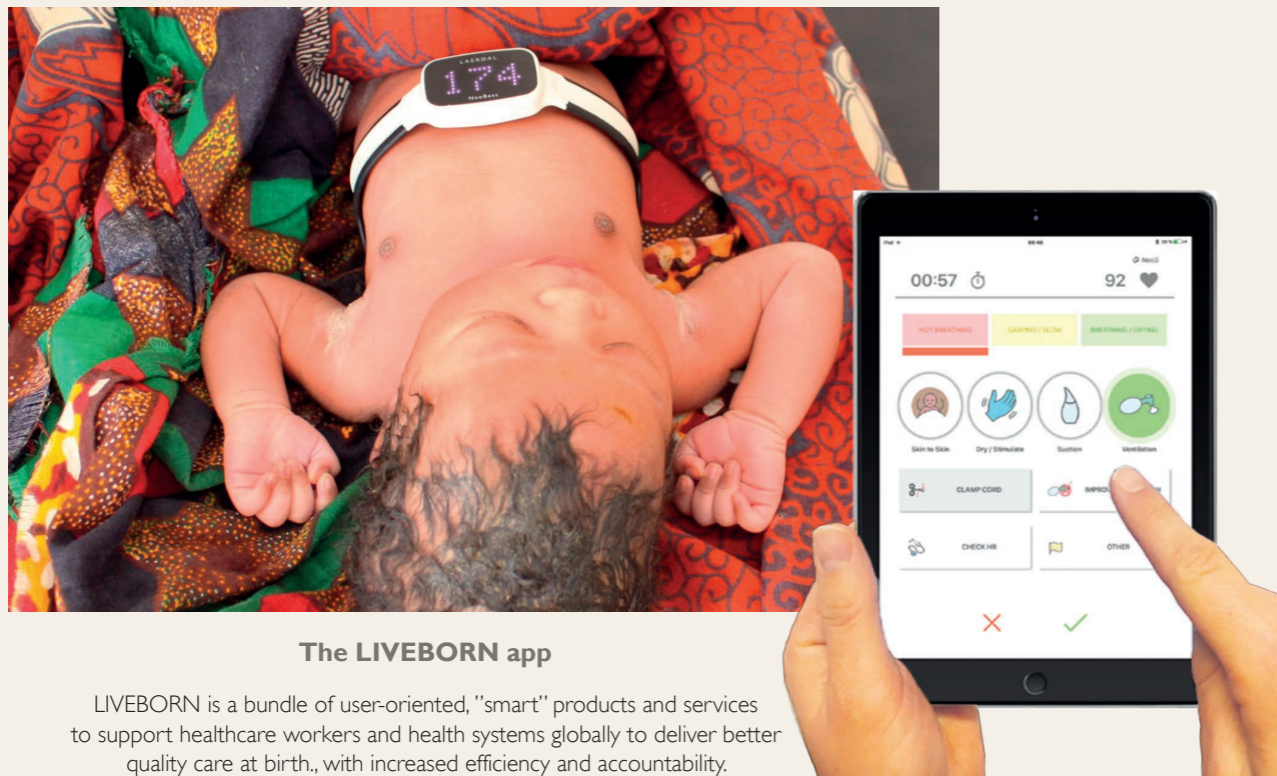
“The collecting and analysing of data from products and services open a whole new world, bringing the use and the outcome of the product and program much closer,” says Helge Myklebust, Laerdal’s Director of Strategic Research. “With NeoNatalie Live, we see every day where the product is used, how it is used, and the competency it created. With our LIVEBORN system we can see every day how babies are resuscitated and what the outcome is.”

Over the coming years, the development of digital platforms will promote easy data collection and utilisation, with data analytics and artificial intelligence used to create value.

Keeping normal births normal

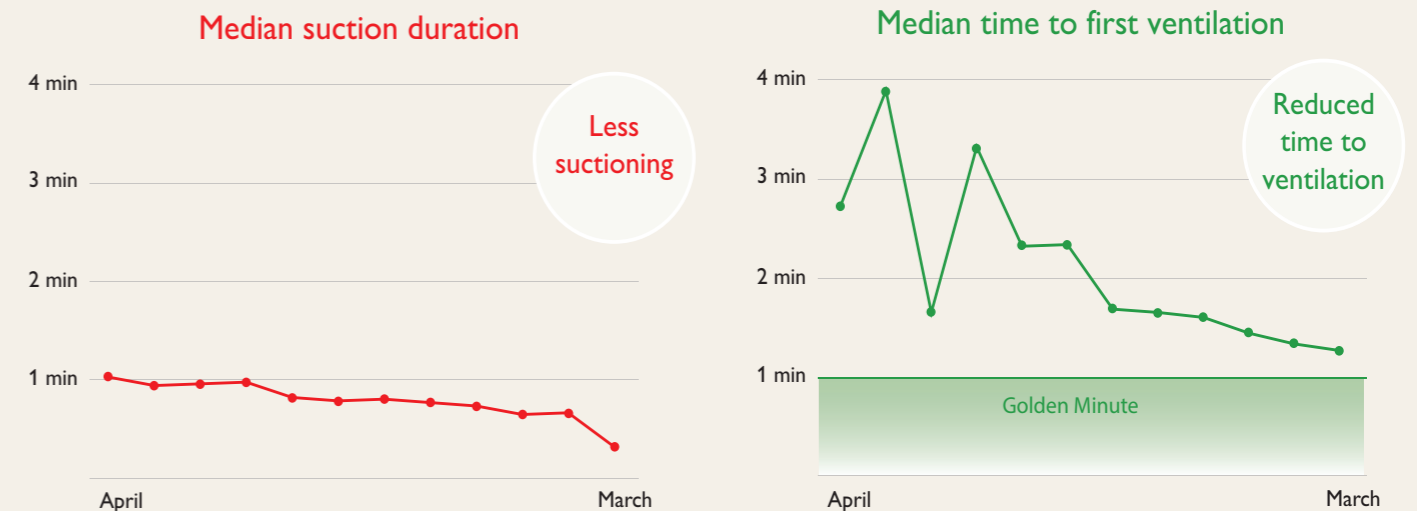
With partners prioritising the prevention and early management of complications, the Helping Mothers Survive programs were expanded to include Essential Care for Labour and Birth and Prolonged and Complicated Labour and Birth for respectful care and support of a well-progressing birth. These programs focus on teamwork and decision-making at the time of birth and are supported by the MamaBirthe birthing simulator and skills trainer which can be used both for simulation and demonstration of birth. A new baby, BabyBirthe, allows training on normal as well as vacuum-assisted delivery.

The Liveborn app is now being used at 12 hospitals in 4 countries. From April 2019 to March 2020, about 18 000 births were observed. Among these over 500 babies were resuscitated with ventilation. The data collected with the Liveborn app show an improvement in quality of care/improved management of birth asphyxia.



The LIVEBORN app

LIVEBORN is a bundle of user-oriented, “smart” products and services to support healthcare workers and health systems globally to deliver better quality care at birth, with increased efficiency and accountability.





Caesarean-section simulator in use in Cambodia.

Safer Caesarean sections and anaesthesia

Devising low-cost and effective training programs for preventing unnecessary Caesarean (C)-section is gaining priority. Too little too late, too much too soon, is often used to describe the dual challenge around C-section. Whilst a C-section is a lifesaving intervention when needed, a problem that is coming into focus is the wide-spread use of unnecessary C-sections as well as unsafe C-sections. Building on the MamaBirthe training solution, LGH has developed a new C-section trainer to help ensure that when the procedure is needed it is carried out safely.

A parallel need relates to better anaesthesia training, and equipment more affordable for LMICs. The Utstein meeting on Safer Surgery and Anaesthesia in 2019 looked at indicators and charted the reality. Building local knowledge – including technical knowledge – is essential. Low-cost anaesthesia machines that supply their own oxygen are a perfect case for collaboration. One of the successful projects in the GFF Innovation-to-Scale initiative is providing simulation-based, on-site training to teams in Tanzania and Sierra Leone who will be users of these new anaesthesia machines.

Family planning

More active family planning through access to sexual and reproductive health care is essential for ensuring healthy lives. A two-year spacing between births may also help reduce birth-related deaths by 10%. India's Family Planning 2020 program entails providing contraceptive services to 48 million new users, aiming to prevent 1 million infant deaths and over 42,000 maternal deaths by 2020. At the request of, and in close collaboration with, the Indian Ministry of Health and Family Welfare, LGH has designed an affordable, portable, modular training solution for wide-scale intrauterine contraceptive device insertion.

Coming full circle

Laerdal has been involved in helping save the lives of infants and babies in HICs for more than half a century. It is only relatively recently that significant efforts have been directed to LMICs and included the health of the mother as well. The lessons learned from this, with the imperative to develop solutions that were highly cost effective and improved

the efficiency of the limited pool of nurses and midwives, can also be translated to HICs where both human and financial resources are being increasingly stretched.

It was in the mid-1960s that Laerdal introduced its first baby, Resusci Baby. The AHA guidelines for neonatal resuscitation were published in 1980 with support from the company. SimBaby, a high-fidelity simulator first introduced in 2003 and recently updated, continues to serve the needs of the AHA Pediatric Advanced Life Support course.

In addition, an alliance with the UK Bristol-based company, Limbs & Things, over many years has supported skills training and higher-fidelity birthing simulation.

Laerdal's involvement in neonatal well-being has accelerated over the last three decades in its close partnership with the American Academy of Pediatrics and its Neonatal Resuscitation Program (NRP) which was launched in 1987. The program is now used in 130 countries with over 200,000 instructors and over 4 million providers trained. SimNewB, first introduced in 2008 with the second generation following in 2019, and Premature Anne were designed especially for this program. And it was this involvement with the NRP that stimulated the formation of LGH.

A prime example of how solutions originally designed for low resource settings can serve the needs of HICs is the NeoBeat newborn heart rate monitor. This innovation was developed to support the Helping Babies Breathe (HBB) program. Supported by the WHO and the Gates Foundation, researchers have validated the NeoBeat at a network of hospitals in Europe and Australia, comparing its efficiency during real resuscitation with traditional tools. It has generated such great interest in those validation sites that they want to use it themselves. They find that this simple, low-cost pulse monitor provides heart rate data much quicker than their pulse oximeters and is much easier to apply to a newborn than traditional ECG electrodes, enabling lifesaving ventilation to be started sooner.



Training in post-partum intrauterine device insertion in India.

Jan's Story

Jan Vastvedt had worked at Laerdal for 15 years. He had practised CPR numerous times on manikins but never done it for real. That is, until he and his wife saw an elderly man unconscious on the ground.

His wife called the paramedics whilst he started CPR. When the paramedics arrived, they defibrillated the elderly man successfully. The man, aged 81, made a full recovery.

The Laerdal commitment

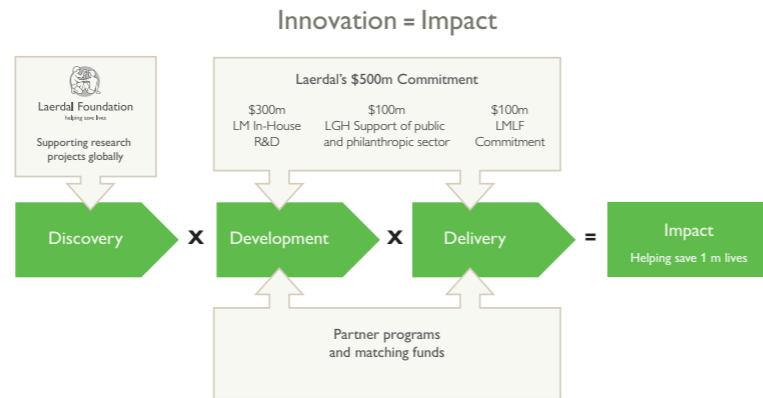
Ever since modern lifesaving techniques were developed around 1960, Laerdal Medical (LM) has worked closely with partners to improve the response of healthcare systems to life-threatening emergencies. The company today employs 1,600 people in 25 countries. Its success over the years enabled the shareholders to establish the Laerdal Foundation, an independent charity which supports research in acute medicine and global health. In 2010, the not-for-profit company, Laerdal Global Health (LGH), was formed, followed in late 2019 by the impact investment Laerdal Million Lives Fund (LMLF).



Laerdal believes innovation is about impact and that impact is about collaboration. To that end over the years the company has partnered with many professional associations and NGOs and will continue to do so over the next ten years to help achieve the shared goal of saving one million more lives every year. But this cannot be done without a commitment of significant resources both by the company and by its partners. In addition to the support to the Laerdal Foundation, which in turn supports research projects globally in what is generally called the “Discovery” phase of innovation, Laerdal is committing to spend up to \$500m over the next ten years for the “Development” and “Delivery” phases on the road to innovation and impact. Up to \$100m in matching funds will be sought from other investors.

Opposite page: Jan Vastvedt





Research support

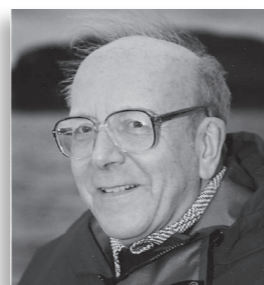
The Laerdal Foundation provides financial support for practically-oriented research consistent with the company's mission of helping save lives.

The Foundation's capital has grown about 40 times over the subsequent 40 years with continued contributions from the company and personal contributions from Tore Lærdal and his siblings, Astrid and Åge.

In addition to providing grants to centres of excellence in North America, Scandinavia and Asia, the Foundation has supported close to 2,000 research projects including more than 25 expert meetings held at Utstein Abbey, near Stavanger, Norway.

The format for these Utstein meetings has proven so successful that it has also spawned a number of so-called Utstein-style meetings supported by the Foundation in other venues including on an update of the Utstein template for cardiac arrest (Melbourne 2016), on drowning (Amsterdam 2016), and on developing emergency care systems to reduce perinatal mortality (GRA Singapore 2018).

"The Utstein conferences have given a language and a method of assessing results and of making international comparisons within resuscitation."



Douglas Chamberlain
Early defibrillation pioneer.

Opposite page:
six of the 30 Utstein Guidelines papers.
See bibliography for full list.



The collage displays six papers from the Utstein series, each with its title and authors. The papers include:

- Setting a Research Agenda for Simulation-Based Healthcare Education: A Synthesis of the Outcome From an Utstein Style Meeting** by S. Barry Issenberg, MD, et al.
- Cardiac arrest and cardiopulmonary resuscitation outcome report and simplification of the Utstein templates for resuscitation registration** by International Liaison Committee on Resuscitation (American Heart Association, European Resuscitation Council, Australian Resuscitation Council, New Zealand Resuscitation Council, Heart and Stroke Foundation of Canada, Inter-American Heart Foundation, Resuscitation Council of Southern Africa), et al.
- Setting a Research Agenda for Simulation-Based Healthcare Education: A Synthesis of the Outcome From an Utstein Style Meeting** (duplicate title).
- Recommended guidelines for reporting on emergency medical dispatch when conducting research in emergency medicine: The Utstein style** by M. Castrén, R. Karlsten, F. Lippert, E.F. Christensen, E. Bovim, A.M. Kvam, I. Robertson-Steel, J. Overton, T. Kraft, L. Engerstrom, L. Garcia-Castriello, et al.
- The formula for survival in resuscitation** by Edgar Sunde, L. Laune Mortensen, K. Ken Hillman, Koen Menikoff, Kristi Sunde, David Zelenka, Mickey Eisenberg, Fritz Steyer, Viway M. Nairam, et al.
- Setting a Research Agenda for Simulation-Based Healthcare Education: A Synthesis of the Outcome From an Utstein Style Meeting** (duplicate title).

In-house development

\$300m will be invested over the next ten years in developing strategic competencies and innovative solutions through in-house product designers and developers and an increasingly large network of development partners. An increasing number of these are focused on digital solutions in Laerdal facilities in Stavanger, Copenhagen, Bangalore, and in Washington DC where B-Line Medical, a leading provider of network and cloud-based video services is based.



Stavanger, Norway
Creating simulation-based educational solutions in resuscitation, emergency care, and maternal newborn health



Copenhagen, Denmark
Creating digital learning solutions for patient care and resuscitation



Texas, US
Creating simulation-based educational solutions with a focus on nursing



Bangalore, India
Creating digital learning solutions for patient care and resuscitation



Washington DC, US
Creating video-enabled debriefing solutions for simulation and clinical care

Support of global health

Laerdal Global Health and the Laerdal Foundation, at the closing ceremony of the Partnership for Maternal, Newborn & Child Health (PMNCH) Forum in Delhi, Dec 13, 2018, increased their pledges of support for the UN Every Woman Every Child Call to Action from \$45m to \$110m. About two thirds of this amount will support programs to train and equip one million birth attendants to become more efficient life savers.

The remaining one third will be contributed through the Laerdal Foundation in support of research projects to reduce maternal and newborn mortality including the Safer Births program in Tanzania and Nepal.

Impact investment

The Laerdal Million Lives Fund was established in late 2019 to invest up to \$100m in ed-tech solutions and healthcare technologies that can contribute to Laerdal's impact goal of helping save one million lives every year by 2030. The fund will support implementation and scaling of transformative innovations that complement the existing operations at Laerdal Medical and Laerdal Global Health and those that reach into new areas that could have a long-term impact on the goal.

The focus is on:

- Medical Education Coverage & Quality including recruitment and retention tools, staffing solutions, guideline and certification development, and clinical decision support.
- Neonatal & Maternal Health including family planning, pregnancy care, sexual and reproductive health, and neonatal monitoring.
- Emergency Care including sudden cardiac arrest, trauma, sepsis, and stroke.

Current investments are listed at laerdalmillionlives.com

Matching funds

Laerdal aims at leveraging its support with matching funds from other sources. Examples of this are with Gavi (see page 72) and the Global Finance Facility (see next page).

Compelling cost/benefit

If the impact of the \$500m investments covered in this chapter, together with matching funds of \$100m from other investors, comes to fruition, then it will have been a highly cost effective use of funds amounting to a cost per life year saved of \$1.20 (assuming a residual benefit of the interventions for 5 years beyond 2030). Although the costs exclude those incurred by partners, this cost per life year saved is many orders of magnitude lower than the amount normally set for medical devices and pharmaceuticals that make them eligible for government funding.

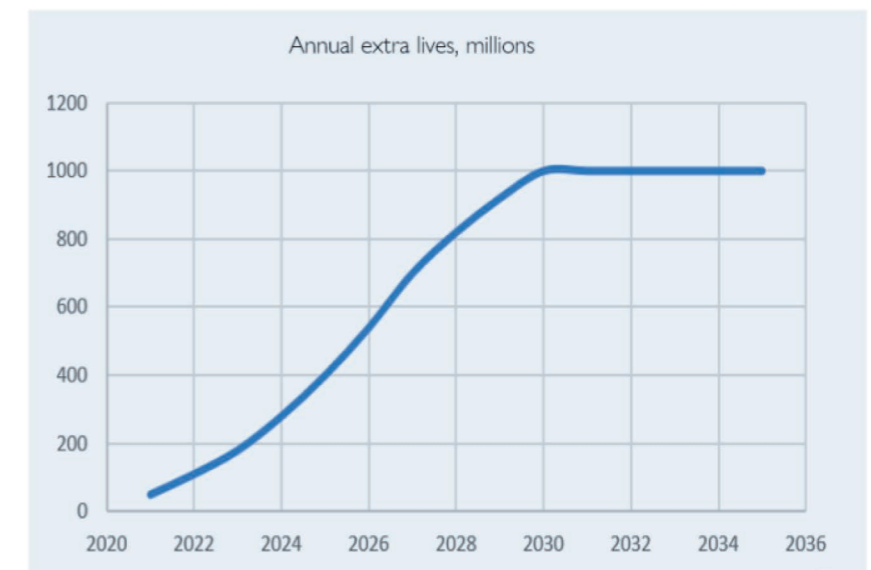


The investment cost/benefit

Accumulated saves of 10 m lives = 500 m life years. Total Investment \$600m.
Cost per life saved \$ 60, Cost per life year saved \$ 1.20

Assumption
Program will be self-sustainable for 5 years beyond 2030:

Year	Annual extra lives '000
2020	0
2021	50
2022	110
2023	180
2024	280
2025	400
2026	540
2027	700
2028	820
2029	920
2030	1000
2031	1000
2032	1000
2033	1000
2034	1000
2035	1000
Total	10000



Innovation-to-Scale

In March 2019, the Global Finance Facility (GFF), a division of the World Bank, and Laerdal issued a Call for Proposals on an Innovation-to-Scale initiative for proven innovations to reduce maternal and newborn mortality around and just after birth. Five grants were to be awarded through this call for proposals, each up to US\$5 million over three years. Laerdal had committed \$12.5m with matching funds from the GFF. The aim was to use this funding as a catalyst for mobilising co-funders for future scale up of the successful programs in 50+ GFF countries.

Three hundred and twenty proposals were received from 26 eligible GFF countries. These underwent a rigorous review process to ensure that they were backed up by evidence that they reduced maternal and newborn mortality; had an established proof-of-concept, including field pilot demonstration; and could be effectively delivered in low-resource conditions to achieve quality and improved outcomes at scale. The proposal review committee was chaired by the GFF Secretariat and included representatives from the GFF Investors Group private sector constituency, the GFF Trust Fund Committee, Laerdal Global Health, the government of Norway, and UNICEF. Five winners were announced on December 19, 2019.

Opposite page: midwife Shemsiya Teyib is introducing the 50,000 Happy Birthdays project to Erna Solberg (left), Norwegian Prime Minister, and Meseret Zelalem (right), Director for Maternal, Child Health and Nutrition at the Federal Ministry of Health, at a health centre in Addis Ababa in February 2020.

At the same meeting the KMC GFF Award winning project was also presented.

“The GFF Innovation-to-Scale initiative will not only help ensure the health and well-being of countless numbers of women and children around the globe but also serve as a catalyst for future private sector contributions, thus inspiring a more peaceful, equitable world.”



Bill Gates

Founder of MicroSoft and philanthropist



Winners of the GFF/Laerdal Call for Proposals

Haydom Lutheran Hospital (Tanzania) will scale up its “Safer Births” bundle to 30 hospitals in six regions of Tanzania accounting for one-third of national maternal and neonatal mortality.

Addis Ababa University, Mekelle University, Hawassa University, Emory University, and Harvard University (Ethiopia) will scale up Kangaroo Mother Care (KMC) coverage from 5 percent to 80 percent within a three-year timeframe in four regions of Ethiopia.

Gradian Health Systems (Tanzania, Sierra Leone) will build upon and further institutionalise anaesthesia simulation laboratories and mentorship programs for users of Gradian Health’s Universal Anaesthesia Machine.

SUMMIT Institute of Development (Indonesia) will use a tablet-based, open-source, decision-support and client record system (“OpenSRP”) to support frontline midwives and community healthcare workers.

AMAPED (Mali) will strengthen quality obstetric and newborn services in Mali, strengthening the continuum of care in 200 community health centres and neonatal intensive care in nine hospitals.

A sustainable future

The preceding chapters have described the ambitious goal of helping save one million more lives, every year, by 2030, and the needs and opportunities that drive the strategy to achieve this. The UN Sustainable Development Goals (SDGs) which have been signed by 195 governments are being used as a roadmap to develop national policies on sustainability, and for Laerdal SDG3 Good Health and Well-being is at the core of everything it does. The SDGs also cover environmental issues and companies are increasingly being asked by civil society, government institutions, customers and employees:

“How sustainable are your operations?”

Laerdal is a member of the UN Global Compact which encourages businesses worldwide to adopt socially responsible and environmentally-friendly business practices and to report on their implementation.

Recent attention has focused on the impact of a company’s operations on climate change and pollution of the planet with materials, especially plastics. This chapter will address Laerdal’s ambitions in these two areas and widening its social responsibility, and the long-term commitment of the Laerdal family to the company achieving its mission of *Helping Save Lives* in a sustainable way.

Opposite page: the Laerdal extended Executive Management Team celebrate the SDGs at Utstein Abbey, outside Stavanger.



Laerdal's environmental ambitions

Laerdal Medical's Board of Directors recently approved an ambitious strategy to ensure sustainability and competitiveness through the next decade encompassing carbon emissions, circular solutions and corporate social responsibility throughout the supply chain.

Carbon Neutral, Circular Solutions and UNGP Compliance throughout Laerdal's business and supply chain by 2030		
Measure to Improve		
Carbon neutral Achieve a minimum of 70% reduction in carbon emission by 2030 across: <ul style="list-style-type: none"> • Facilities • Transport and travel • Supply chain Offset any residual emissions.	Circular solutions Circular Materials throughout the value chain: <ul style="list-style-type: none"> • Reduce, Reuse, Recycle • Design sustainability into new products 	Social responsibility Implement UNGP and OECD guidelines throughout our supply chain and cascade to the next level from the largest suppliers.

As part of this strategy, Laerdal is developing a sustainability model with elements based on the "Future Fit" one used by another Scandinavian healthcare company, Novo Nordisk. The essence of the model is to integrate into every business decision - including product development - an assessment not only of how the positive impact of the decision can be increased but how any negative impact can be reduced compared with previous solutions.

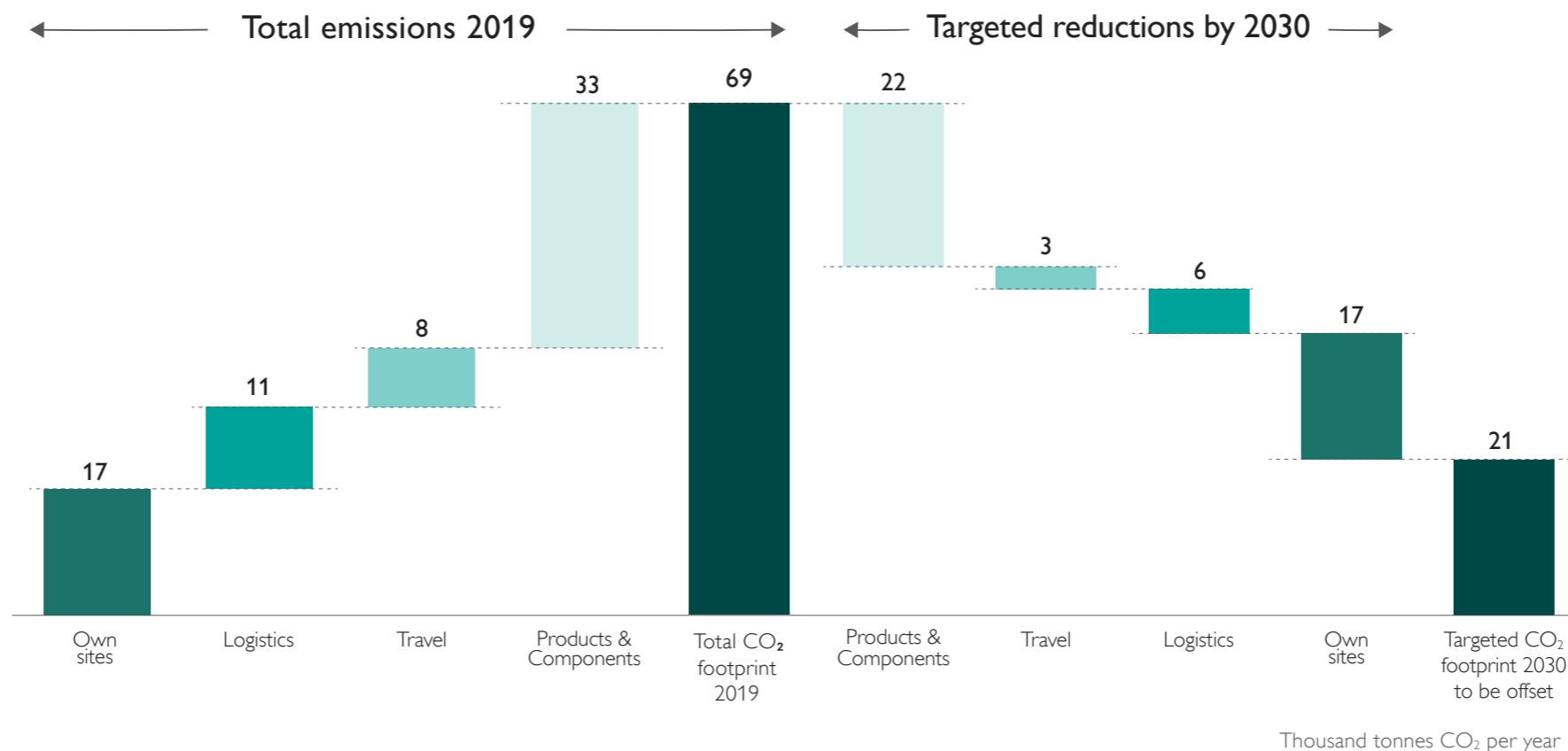
Carbon neutral

A pre-requisite of any company's ambition to be carbon neutral is to have an accurate assessment of its carbon emissions. Many companies exclude the emissions used to produce the goods they purchase, effectively exporting some of their emissions to others. This is, however, changing with companies increasingly looking beyond their own operations.

A detailed assessment has been carried out by external consultants of the greenhouse gas emissions associated with Laerdal's overall purchases and activities in 2019. This carbon footprint includes all emissions taking a life-cycle perspective, including direct on-site emissions, and all indirect emissions sustained upstream in the supply chain of the goods and services purchased by Laerdal.

The total carbon footprint in 2019 is estimated at 69 thousand tonnes CO₂. Laerdal's ambition is to reduce this total by about 70% to 21 thousand tonnes by 2030. This will be very challenging given the need for Laerdal not only to "think green" in all elements of its operations from research and development through to manufacturing, sales and distribution but also to secure similar commitments from its suppliers. Nevertheless, it is felt to be a realistic goal and matches Laerdal's other ambitious goals.

Any residual emissions will be offset by initiatives such as planting trees or investing in green technologies.



One million trees

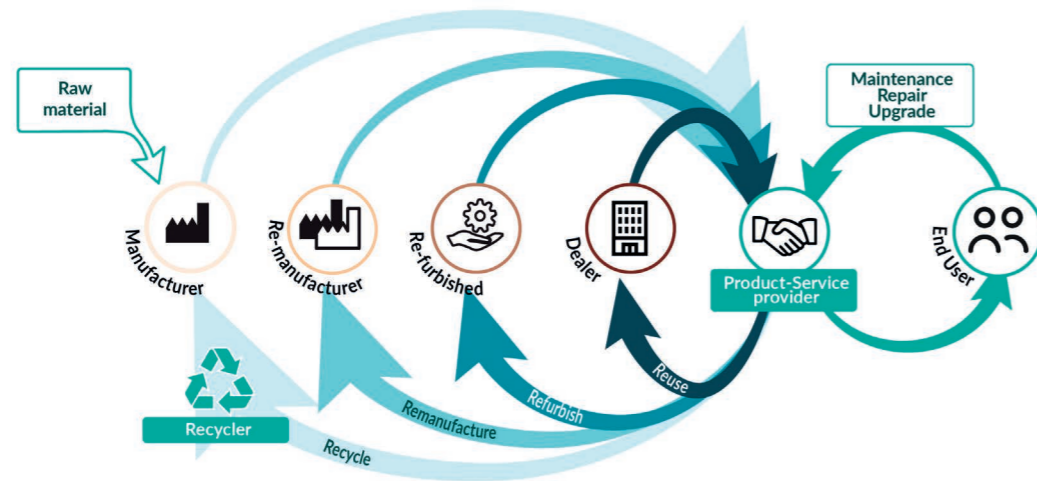
Ten years after planting an average tree will absorb about 21kg of CO₂ per year from the atmosphere. This means that one million trees planted now will offset residual emissions of 21 thousand tonnes CO₂ from 2030 onwards.

One million trees and one million lives - a remarkable synchronicity.



Circular solutions

Estimates of how much plastic material enters our seas every year vary from 4 to 12 million tonnes, but whichever figure is correct it is causing great public concern about the impact on both wildlife and, ultimately, human health. Whilst waste disposal is a focus of attention, there is also a need for companies to move towards a “circular economy” where plastic materials constantly flow around a ‘closed loop’ system, rather than being used once and then discarded.



Laerdal uses about 2300 tons of virgin plastic material every year to manufacture its products and the ambition is to reduce this to zero by 2030. This will in part be achieved by using recycled or recyclable material and by recycling products after they come to the end of their useful life. But the major contribution will come from designing sustainability into the company’s products to increase both life expectancy and efficiency of use. A good example of the latter is CPR Classroom, described in an earlier chapter. Partial “dematerialisation” of products with an increasing proportion of digital solutions will play an increasing role as it will for reducing carbon emissions.

Social responsibility

Laerdal has been committed to operating in accordance with the UN Global Compact principles for several years. In addition, the company is committed to the UN Guiding Principles on Human Rights (UNGPs) and the Organisation for Economic Co-operation and Development (OECD) Guidelines for Multi-national Enterprises which set environmental and anti-corruption standards for responsible business conduct.

The OECD guidelines are unique as regards:

- clear recognition of supply chain responsibility;
- backing by signatory governments;
- grievance mechanism for resolving conflict.

They are not legally binding on companies, but they are binding on signatory governments, which are required to ensure the guidelines are implemented and observed.

In addition to its biannual reporting, Laerdal will be communicating more widely to customers, employees and suppliers on how its commitment to the UN SDGs and the UNGPs and OECD guidelines are integrated in operations. Also, a key element of Laerdal’s 2030 strategy is to develop a human rights, environmental and anti-corruption assessment tool to assist its main suppliers and their sub-suppliers to comply with these international guidelines.





A sustainable culture

Since its establishment 80 years ago, Laerdal has had the full commitment of three generations of the Lærdal family as both shareholders and in the management of the company. From its founding, the company has moved seamlessly from children's books and toys to lifesaving equipment.

Tore Lærdal has been at the helm of the company for close to half of its history after the premature death of his father in 1981. The company has grown to be truly multinational with operations in 25 countries and has adhered to the basic values set out by the founder which are handed to all Laerdal employees on their first day of work – pride in their history, a clear vision,

a sound company culture, a willingness to learn, a passion for continuous improvement, a commitment to sustainable development, and a dedication to help improve global health.

All Tore's three children – Hanne, Jon, and Ingrid – have chosen to devote their lives to working in the company with a deep commitment to the goal they share with partners and collaborators. This provides a stable and trustworthy base for working with long-term perspectives. From the outset, financial results were re-invested in development and innovation instead of being siphoned off to shareholders.

Three generations meet in The Norwegian Children's Museum: to the left, a depiction of the founder, Åsmund S. Lærdal, experimenting in his kitchen in the 1950s. To the right, in the greatly upscaled Tomte Mercedes, Hanne Kristin Lærdal, Tore Lærdal, Jon Åsmund Lærdal, and Ingrid Lærdal.

People who find meaning in their work

All along, Åsmund S. Lærdal stressed that when he demanded the utmost of his employees – and, not least, of himself – it was because the work was meaningful: initially, to create joy for children, and eventually, to help save lives. He was ahead of his time: it is now generally accepted that people who find meaning in their work are happier, more productive, and more engaged. They are more likely to work harder, take on challenging or unpopular tasks, and collaborate effectively. Studies have shown, repeatedly, that people deliver their best efforts and ideas when they feel they are part of something larger than the pursuit of a paycheque.

Among the crucial points here are helping people grasp the impact of their work and connecting work to a higher meaning. Ingrid Lærdal illustrates this when explaining her motivation to take an active role in the company: “I went with my father to India and Africa, and what I saw there would have made it very difficult to do something different. We can be part of making a difference. Innovation depends to a high degree on being out in the field with the users, working on ideas and having feedback to identify what is really the best solution.”

Trust in the meaningful mission

As modern technologies bring user and supplier much closer together, daily proof that Laerdal programs are really making a difference illustrates that together it is possible to fulfil audacious commitments. This can strengthen even further the trust in the meaningful mission – thus adding to the sustainability of the company culture.

Hanne Lærdal stresses the crucial importance of the company vision and mission, doing the right things at the right time, and working continuously to improve the situation for users and collaborators. “We must continue to build strong relationships based on mutual trust.”

Her brother, Jon, emphasises this when he underlines that making the company strong and relevant in the future is a matter of meeting needs with delivering ever better value. For an illustration he refers to John Deere, an agricultural machine manufacturer: “They moved from making tractors for the farmers to do all the work to deliver new solutions in the form of crop optimisation. People have been linear, but

now suddenly the world develops exponentially. By applying enabling technologies, we can help people plug into each other and into networks, and we deliver improvement for lay people as well as professional workers.”

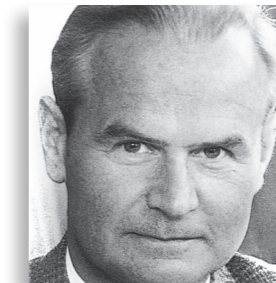
The establishment of Laerdal Global Health in 2010 extended the mission to help save lives to include low-income countries. This opened a huge potential for saving the lives of mothers and babies and increasingly those of adults suffering from the ravages of ailments such as cardiovascular disease – no longer the blight of richer citizens alone.

The task is enormous, requiring wide networks and collaboration to disrupt costly and insufficiently effective systems and replace them with true innovation and rapid implementation. This demands new approaches also to financing. Thanks to the values that the founder lived and passed on to the coming generations, Laerdal can contribute on a wide scale, including through the recently established Laerdal Million Lives Fund.

Balancing the shared goal of helping save one million more lives a year by 2030 with the need for financial success to provide the resources needed to meet this goal is not an easy one.

But, to quote the founder:

“If we can create value to the society at large, and do our job well, satisfactory economic results will follow – and allow us to build a stronger company with time.”



Åsmund S. Lærdal

Publications

The following is a list of recent publications that have guided Laerdal's strategy or been used by the authors in writing this book.

A shared goal

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Improving survival in the community

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ABBREVIATIONS

AAP	American Academy of Pediatrics	OSCE	Objective Structured Clinical Examination
AED	Automated External Defibrillator	PALS	Paediatric Advanced Life Support
AHA	American Heart Association	PAROS	Pan-Asian Resuscitation Outcome Study
ALS	Advanced Life Support	PMNCH	Partnership for Maternal, Newborn & Child Health
BHF	British Heart Foundation	PPE	Personal Protective Equipment
CPR	Cardiopulmonary Resuscitation	PSM	Patient Safety Movement
DALY	Disability-Adjusted Life Year	QCPR	Quality Cardiopulmonary Resuscitation
DNT	Door-to-Needle Time	QI	Quality Improvement
ECG	Electrocardiogram	R & D	Research & Development
EMS	Emergency Medical Service	RQI	Resuscitation Quality Improvement
EMT	Emergency Medical Technician	SAFE	Safer Anaesthesia From Education
GDA	Global Development Alliance	SAFER	Stavanger Acute medicine Foundation for Education and Research
GFF	Global Finance Facility	SDG	Sustainable Development Goal
GRA	Global Resuscitation Alliance	SUS	Stavanger University Hospital
HALE	Health-Adjusted Life Expectancy	T-CPR	Telephone-Cardiopulmonary Resuscitation
HBB	Helping Babies Breathe	UIS	University of Stavanger
HEROS	Home Education and Resuscitation Outcome Study	UN	United Nations
HIC	High-Income Country	UNGP	United Nations Guiding Principles on Human Rights
HMS	Helping Mothers Survive	UNICEF	United Nations Children's Fund
ICT	Information and Communication Technologies	US	United States
IUD	Intrauterine Device	USAID	United States Agency for International Development
IV	Intravenous	VR	Virtual Reality
KMC	Kangaroo Mother Care	WFSA	World Federation of Societies of Anaesthesiologists
LDHF	Low-Density, High-Frequency	WHO	World Health Organization
LGH	Laerdal Global Health		
LM	Laerdal Medical		
LMLF	Laerdal Million Lives Fund		
MPL	Medical Plastics Laboratory		
NASA	National Aeronautics and Space Administration		
NGO	Non-Governmental Organisation		
NLN	National League of Nursing		
NRP	Neonatal Resuscitation Program		
NY	New York State		
OECD	Organisation for Economic Co-operation and Development		

