MEDICAL GAS CONTROL

FIREBREAKS:

A risk-based approach to safer home oxygen delivery

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Executive Summary

How firebreaks could help the home oxygen industry reduce the medical and financial burden of oxygen fires

In September 2019, BPR Medical reported that someone dies in a home oxygen fire at least every four days in the US.[1] Now, new analysis confirms that these fires remain a material public health challenge. Installing firebreaks for high-risk patients could save many Americans from deaths and injuries each year.

While the absence of a formal reporting system makes it impossible to determine the true prevalence of home oxygen fires, our analysis of media reports in 2019 suggested that home oxygen fires led to at least 100–150 deaths per year.[1] Beyond the human impact of fatalities and serious burns, these fires carry a significant financial burden, with eye-watering medical costs and millions of dollars' worth of property damage. The findings of our most recent analysis, shared in this report, confirm that home oxygen fires remain a public health issue.

Most home oxygen fires are caused by patients smoking while on oxygen. Oxygen service providers have been educating patients on the risks they face for many years, but changing the habit of a lifetime can be difficult, especially given nicotine's addictive properties. Safety advice can also be tough to retain if the patient's symptoms cause confusion or forgetfulness.

But there's a further solution. Effective and easy to install, oxygen firebreaks can help to ensure patient safety for up to five years. They may not eliminate the risk of fire, but they can drastically reduce the risk of severe burns, death, and explosions that endanger nearby people and property.

How firebreaks could help the home oxygen industry reduce the medical and financial burden of oxygen fires

With home oxygen fires causing more than 1000 burns per year,[2] and complex burns cases racking up costs in excess of $1 million,[3] these small devices are a smart, safe investment at just a few dollars each.

The home oxygen and medical gas industries are highly motivated to reduce patient risk wherever possible and are attempting to address the issue through patient education. Many providers install firebreaks as a matter of course, but without a regulatory mandate or reimbursement of installation costs, implementation remains inconsistent.

There are small steps in the right direction: the Veterans Health Administration (VA) issued a Patient Safety Alert in 2018, mandating firebreak installation.[4] But this guidance only applies to 6-7% of patients. There are around 1.4 million home oxygen users in the U.S., up to half of whom may continue to smoke.[5] With no comprehensive regulation on the horizon, it's on us as an industry to take the lead.

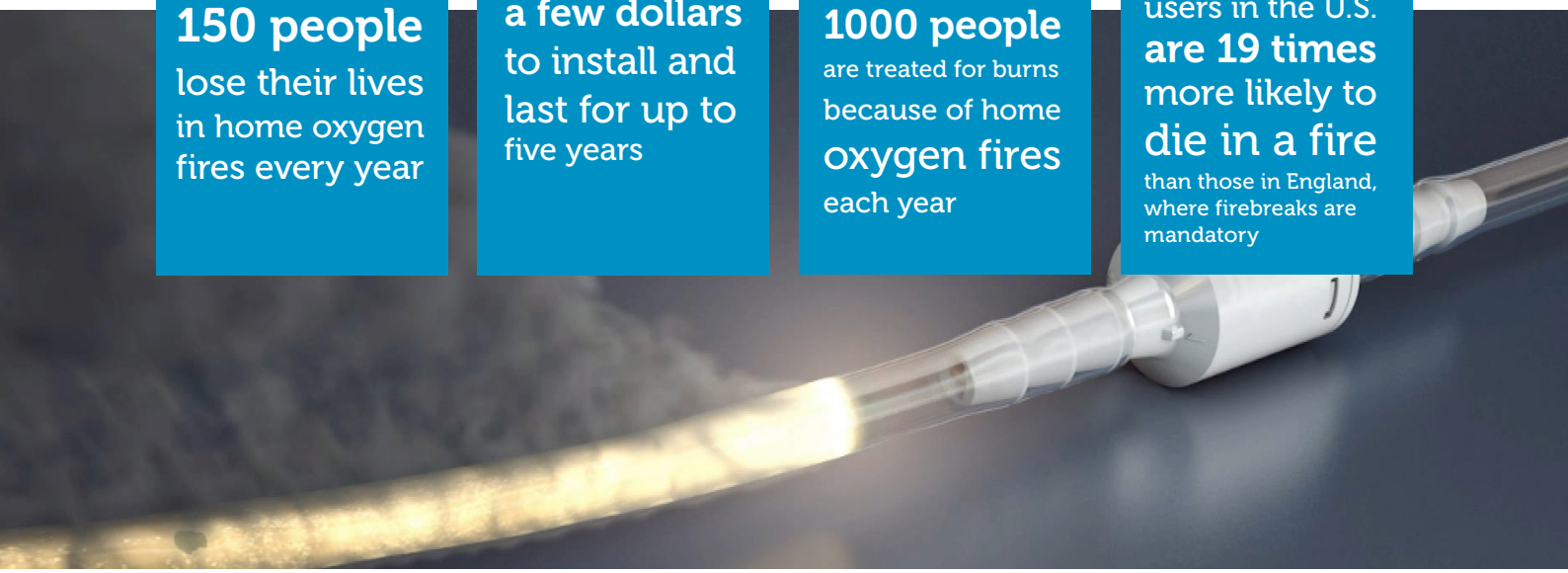
Focusing on installing firebreaks for the highest risk patients would be an effective intermediate step to reduce the medical and financial burden of home oxygen fires.

Around 100-150 people lose their lives in home oxygen fires every year

Firebreaks cost **a few dollars** to install and last for up to five years

More than 1000 people are treated for burns because of home **oxygen fires** each year

Home oxygen users in the U.S. **are 19 times** more likely to **die in a fire** than those in England, where firebreaks are mandatory



INTRODUCTION

Smoking on oxygen: a dangerous mix

Home oxygen therapy (HOT) allows patients with challenging respiratory conditions such as chronic obstructive pulmonary disease (COPD) to benefit from supplementary oxygen in the comfort of their own home.

Oxygen is delivered through a nasal cannula or mask worn by the patient. The cannula is attached to a pressurized oxygen cylinder, or to an oxygen concentrator, which pulls oxygen from the surrounding air. One of the most common causes of COPD is long-term cigarette smoking. It's a habit that is hard to break even after such a diagnosis, but potentially lethal next to a ready source of oxygen.

Up to half of home oxygen users are thought to continue to smoke. With around 1.4 million home oxygen users in the US, this means that around 700,000 could be putting themselves and others at risk.[5]

How does a home oxygen fire start?

When the lit end of a cigarette is exposed to concentrated oxygen, combustion is highly likely. As the smoker inhales, ignition can occur in a concentration of just 40%. The flame burns through the nasal cannula, causing a flash fire around the patient's mouth and nose. Knowing this risk, some patients remove the cannula when smoking, and rest it in their lap. Unfortunately, even a small amount of falling ash can still cause it to ignite.

In both cases, the fire moves rapidly through the oxygen tube. Oxygen from a concentrator or cylinder will continue to feed the fire, with almost two-thirds of incidents resulting in a devastating 'whole house fire' or severe damage to property or potential explosion.

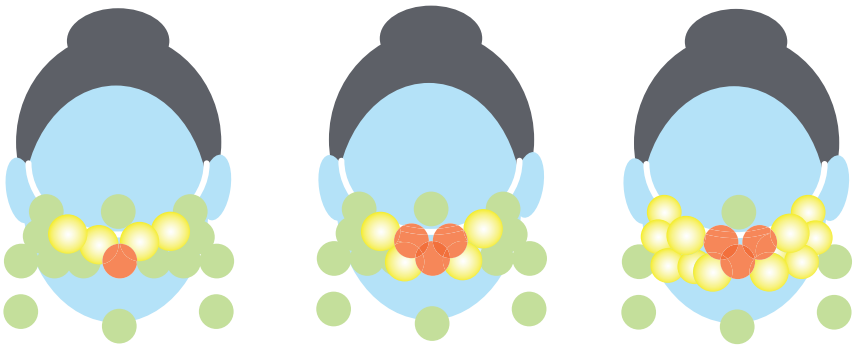
See the video

A safer approach to home oxygen delivery

Despite the horrifying impact of home oxygen fires, a coordinated response to reducing risk remains elusive. In BPR Medical's 2019 report, ***The prevalence and impact of home oxygen fires in the US,*** we aimed to shed light on the scale of the problem. Here, we aim to move the conversation forward to explore why current solutions to the problem of home oxygen fires fall short, and demonstrate the effectiveness of firebreaks in minimizing the risk of serious burns.

Drawing on insights from installers who interact with patients each day, and lessons learned from firebreak use in other countries, this paper makes the case for a risk-based approach to safer home oxygen delivery.

Oxygen concentrations at varying flow rates



1 L/min 2 L/min 4 L/min

Oxygen Levels

Under 25%
No impact on burning

25%-35%
Minimal acceleration to burning

35% +
Increased intensity of burning

> A flow rate as low as one liter per minute is enough to ignite. Most patients use oxygen at a flow rate of between two and four liters per minute. If they smoke while using it, and the circumstances are right, a flash fire is almost inevitable.

Ben Johnson, Technical Director, BPR Medical

SNAPSHOT OF PREVALENCE AND IMPACT

Determining the exact scale of the problem is difficult. Patients may be reluctant to report home oxygen fires, as they may feel responsible or worry that their oxygen will be removed. There's also no uniform federal requirement for firefighting services to specify that home oxygen was involved in a fire, nor a comprehensive requirement for home medical device providers to report incidents to a national body that could monitor the number of incidents.

For these reasons, BPR Medical undertook its own analysis to gauge the likely toll, which was published in September 2019.[1] This suggested a death rate of around 100-150 per year, which was nearly double previous estimates by the National Fire Protection Association (NFPA). Even this may be an underestimation though, as limitations in the study method mean that the data is likely to be incomplete. We repeated the analysis to capture updated figures on the prevalence of home oxygen fires, based on further online media reports gathered since August 2019.

Key findings: between December 2017 and August 2019

Using Google Alerts to identify media reports of residential fires involving home oxygen therapy over a 20-month period, we found:

311 fires involved home oxygen

causing **164 deaths,** equivalent to one death at least every four days

around 1 in 4 incidents

led to an assisted evacuation

oxygen cylinders may have exploded

in a third of incidents, presenting a major risk to other residents, neighbors, emergency services and property

American oxygen users

are 10 times more likely to die in a home oxygen fire than in Japan, and 19 times more likely than in England

** We recognise that there are limitations to this method of data gathering, however in the absence of any formal, consistent, reporting process, we have used online news reports as the only source of information. The data is unlikely to be complete and the number of incidents may well be greater than that reported. The data correlates a fire where home oxygen was present, it cannot be determined that home oxygen was a causal factor in every incident reported. However, many reports state that the fire was started by the person smoking whilst on oxygen.*

Key findings: between August 2019 and July 2021

256 fires involved home oxygen

of which 152 resulted in death

around 1 in 3 incidents

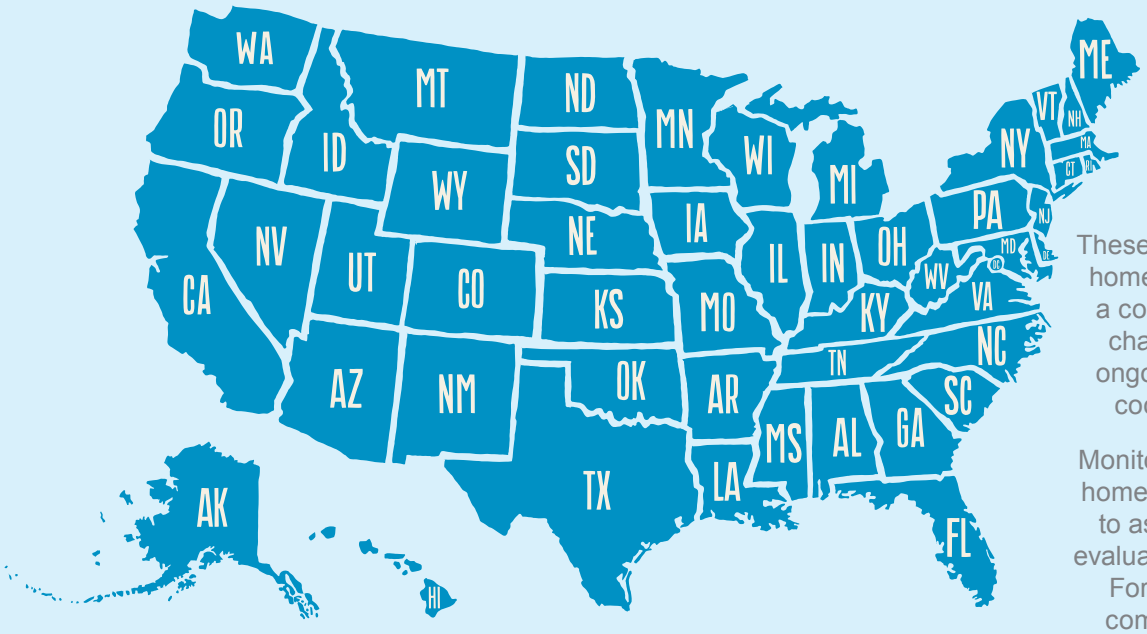
led to an assisted evacuation

3 in 10 incidents

may have resulted in a cylinder explosion

29% of incidents

resulted in the destruction of the resident's dwelling or another dwelling



Incidents occurred in 40 US States *(see Appendix A)*

These new figures show that home oxygen fires present a continuing public health challenge that warrants ongoing monitoring and a coordinated response.

Monitoring the prevalence of home oxygen fires is crucial to assess the impact and evaluate potential responses. For that reason, we are committed to continuing analysis as part of an ongoing research program.

Fire-related burns lead to complex, lengthy and expensive medical treatment

While fatalities and explosions capture the headlines, fire-related burns account for an enormous portion of the human and financial burden of home oxygen fires.

Our recent findings show that of the 256 incidents between August 2019 and July 2021, nearly 60% resulted in a death, and around a quarter caused serious injuries, with thermal burns the likely cause in both cases. According to a study by Wake Forest Baptist Medical Center in 2020, home oxygen fires cause at least 1000 burn injuries per year.[1]

The more severe the burn, the more medical treatment is required. That treatment also comes with a heavy financial cost: more severe cases can rack up costs well beyond $1 million, even without complications, and the most complex cases can exceed $10 million.[3] Patients and their families often face sizable medical bills, and as with any service, providers can end up uncompensated when bills go unpaid. As many COPD patients are eligible for Medicare coverage, a significant portion of these costs also falls to the state.

Serious burns can have even more severe consequences for patients with pre-existing conditions.

Treating a patient with burns injuries is a resource-intensive, long-term endeavor. Most treatment costs occur immediately after the incident, but ongoing care is expensive too. One care management provider[3] reports that infections, failed skin grafts and slow-healing wounds can each add over $100,000 to the total cost of care. Treatment for scarring can add $35,000 while treating the psychological effect of a serious burn can add up to $75,000 per patient.

This involves support from a huge range of specialists, multiple medications, wound care, and emotional support. Patients have a better chance of a positive outcome if they're able to go to a specialist burn center, which often means they need to be transferred between facilities. In one study, 22% of patients were transported to the nearest burns unit by helicopter, at an average cost of $12,500.[6]

Patients often need modifications to their home to accommodate new mobility issues. Those with existing health conditions are at higher risk of poorer outcomes after a burn injury, so for home oxygen users who already have health challenges, the impact of a serious burn can be even more severe. Many need home health care when they are discharged, with many not returning home at all, and moving into residential care instead. Around a third of patients who were previously living at home are unable to return following a burn injury.[7]

> "More than half of patients with burns attributable to smoking on home oxygen die within a year of being discharged.[7]

Why education alone isn't enough to reduce home oxygen fires

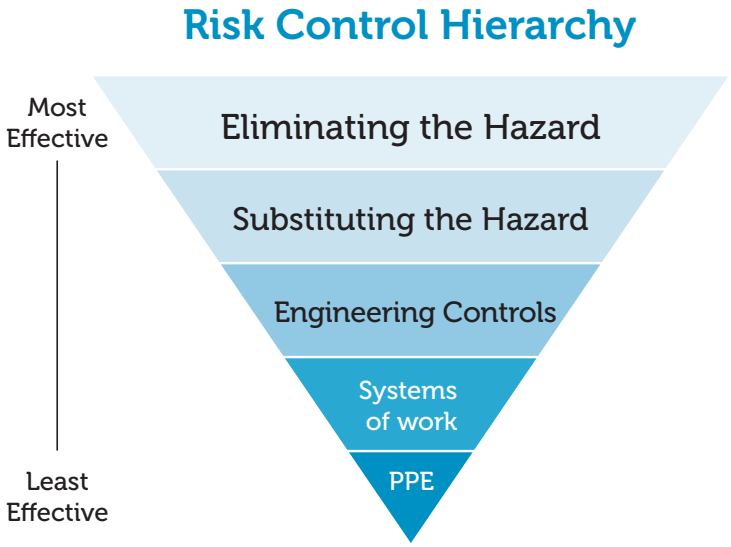
Despite the risk of significant injury and even death, as many as 52% of home oxygen users continue to smoke while using oxygen therapy.[2] We don't know exactly how many, since fear of judgment and fear of losing their oxygen deters many from admitting that they smoke. In one review of veterans on HOT, 89% of those who experienced flash burns said they'd given up smoking, yet 92% of those fires occurred because of smoking.[5] For many, cigarettes are one of their few remaining pleasures in life, and nicotine's addictive nature makes it hard to give up.

While home oxygen therapy providers make a considerable effort to train and educate patients on the risks and dangers of oxygen, evidence tells us education isn't completely effective on its own. A single information session isn't always enough to hammer home the message that smoking while on oxygen is dangerous, especially when there's an in-built tendency to think 'that won't happen to me.' This is amplified by the fact that oxygen is a colorless, odorless gas that's already in the air we breathe, and potentially difficult to imagine as a danger. What's more, patients already have a huge amount of information to absorb about the setup and use of their therapy, so safety advice can be easily forgotten – even more so when the patient's condition causes confusion or forgetfulness. Reports also suggest that not all patients are offered education.[5]

While the benefits of oxygen therapy outweigh the risk of burn injuries,[8] smoking cessation is a requirement for HOT prescription in some countries. For example, the Thoracic Society of Australia and New Zealand recommends against oxygen therapy for people who smoke, due to 'increased fire risk and the probability that the poorer prognosis conferred by smoking will offset treatment benefit.'[9]

While counseling patients on the risks of smoking while on oxygen (and support to stop smoking altogether) is part of the solution, the fact that so many continue to smoke while on oxygen suggests education is not a viable solution on its own.

In accordance with the globally recognised 'Hierarchy of Controls' for risk management, 'Elimination' of the risk is not possible as the patient still requires oxygen, 'Substitution' is also not possible as the therapeutic effect of the oxygen cannot be replicated. Therefore, an 'engineered' solution to 'isolate the patient from the risk' may be the most effective solution.



Could firebreaks solve the problem of home oxygen fires?

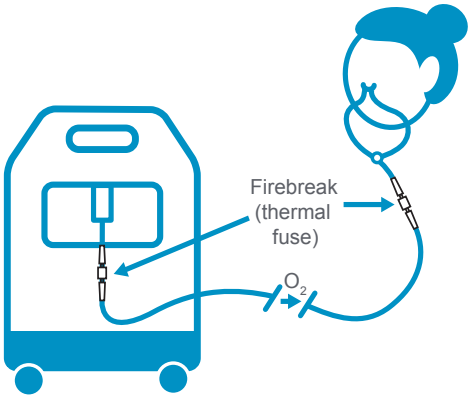
The good news is that another solution exists. Firebreaks are a simple, effective, and inexpensive device that can reduce the impact of a fire, so that it results in nothing more than a minor injury instead of a catastrophic whole house fire.

How does a firebreak work?

A firebreak, (also known as a thermal fuse or fire stop valve), is a safety device that fits into the oxygen delivery tube, close to the patient, to automatically stop the flow of oxygen in the event of a fire. It stops the fire in its tracks and protects the oxygen source, buying time for the patient to evacuate. By limiting the scale of the fire, it can reduce the risk of injury and death for the oxygen user and third parties.

A 2020 study by Wake Forest Baptist Medical Center investigated the effectiveness of firebreaks in nursing homes, assisted living facilities and in patients' homes.[2] Working with local emergency medical services and fire agencies, 225 firebreak kits were distributed, which included firebreak devices and educational information. The number of patients admitted to hospital as a result of oxygen-related burns dropped from 24 per year to nine per year.

While education matters, behavior change is challenging for oxygen users with a long-standing nicotine addiction. Firebreaks provide an extra layer of protection (see diagram).



For a few dollars, a firebreak can protect patients for years


Kalash

Costs just a **few dollars**


Martins Ratkus

Easily fitted by home oxygen **installer**


Laura Reen

Lasts for up to **five years**


Ayub Irawan

Could reduce the death rate from home oxygen fires **from 100-150 per year to just 5 deaths per year**

Use of firebreaks around the world

Thermal fuses are used in over 25 countries around the world. In the UK and much of Europe, firebreaks are required under medical device legislation, and Japan introduced similar requirements in February 2021. Evidence shows that countries with a more coordinated and consistent approach see far fewer home oxygen fire-related injuries and deaths.

In England, where firebreaks have been required since 2006, there are nearly 20 times fewer oxygen fire fatalities per 100,000 patients than in the US.[1] If a similar approach to fire safety was used in the US, the number of deaths could potentially be reduced from 100-150 to as low as five per year.

Why are firebreaks not fitted as standard in the US?

Despite many deaths each year, firebreaks are still not fitted as standard in the US. In March 2018, the VA issued a Patient Safety Alert, requiring firebreaks to be fitted for all their patients, and establishing a reporting structure for firebreak installation and home oxygen-related fires.[4] While this is a huge step in the right direction, VA patients account for only 6-7% of all home oxygen users in the US.

Many durable medical equipment installers (DMEs) do offer firebreaks to any patient they deem high risk, but implementation remains patchy.

"Installing firebreaks is the right thing to do"

In summer 2021, BPR Medical interviewed home oxygen installers to explore their perspectives and experiences of firebreak installation.[11] Around 9 in 10 were aware of the benefits of using firebreaks, and 95% believed firebreaks to be effective. However, nearly 6 in 10 do not install firebreaks as standard. Of those that do, many say it's because 'it's the right thing to do.' Only 10% are contractually obliged to install firebreaks.

OBSTACLES TO CONSISTENT FIREBREAK USE

LACK OF REIMBURSEMENT

LACK OF ENFORCEABLE REGULATION

LACK OF REPORTING

LACK OF COORDINATED RESPONSE

Without regulation, reporting, and reimbursement, consistent use of firebreaks will be unlikely

The biggest obstacle is cost: while firebreaks are only a few dollars each, installers are not reimbursed, which means they bear the cost themselves.

According to installers, the most effective way to achieve a high level of compliance would be through a mandate from the FDA or the Centers for Medicare and Medicaid Services (CMS). Currently, there's no law demanding that thermal fuses be fitted in the US, though any provider using ISO standard ISO 80601-2-69:2014 to demonstrate the safety of their oxygen concentrator would need to have a firebreak. Unfortunately, this requirement isn't consistently enforced. Having multiple decision-makers means implementation varies.

While home oxygen service providers are expected to record safety incidents when they become aware of them, there is no centralized system to report safety incidents directly to regulatory authorities, so there's little evidence or incentive to drive the use of thermal fuses. With multiple manufacturers supplying different parts of the home oxygen set-up, it's not always clear who to inform of safety issues.

A final challenge is the perception that fire risk is a 'user problem': if patients have been advised not to smoke and continue to do so, some feel there's little else the sector can do to improve safety. In fact, some installers worry that fitting firebreaks gives the impression to patients that it's now safe for them to smoke. However, there's no evidence to support this claim. Evidence of the effectiveness of firebreaks continues to grow.

The decision to fit firebreaks varies among home care providers, so owners, senior management and clinical leads can all be involved in the decision to purchase. They also allow discretion on the part of the delivery tech or others calling on the patient, should high-risk conditions be present that weren't previously identified.

Based on feedback from DME provider representatives

The English approach to home oxygen safety

Home oxygen therapy is the same around the world, but the scale and impact of fires vary. The difference lies in how services are delivered. Richard Radford, CEO of BPR Medical, explains:

“In England, a small number of home oxygen providers operate within a carefully regulated market. Safety incident reporting is mandatory. There is also a culture of collaboration between installers, health services, fire services, and regulatory bodies. There are risk assessment checks to ensure the patient has a working smoke alarm, and if they don’t, fire and rescue services come and fit one.

Importantly, firebreaks have been mandated since 2006. Structural differences can be difficult to overcome, but fitting firebreaks is a pretty easy and inexpensive step.”

A risk-based approach to home oxygen delivery: focus on high-risk patients first

In the long-term, the goal should be clearer regulation, more consistent reporting and monitoring, and closer collaboration across the sector. But in the short term, installing firebreaks for the highest-risk patients is an easy and effective step toward fewer fatalities and serious burns.

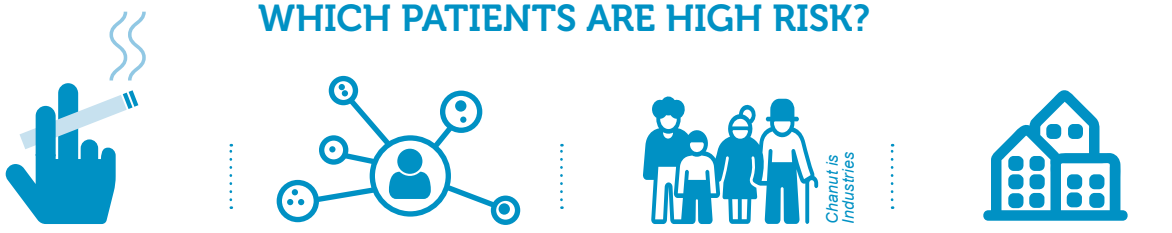
Nearly 3 in 10 of the DMEs we spoke to install firebreaks for 'high risk' patients. Whether or not a patient smokes is the main factor in determining level of risk. Installers also consider if the patient has experienced a fire incident before.

Interestingly, the VA Patient Safety Alert does not limit the use of firebreaks to high-risk patients: every home oxygen user in their care gets one. They recognize that smoking isn't the only fire risk: candles, cookers, household appliances and electronic devices can also cause ignition.

While universal use of firebreaks would be ideal, prioritizing high-risk patients could still reduce fatalities and serious burns considerably. A 2016 review of flash burns experienced by VA patients using home oxygen concluded that patients with a history of smoking should be considered for fire stop valves and offered consistent counseling and follow-up.[5] The authors also recommended considering patient age, lifetime smoking history, comorbidities (including mental health status and substance use) should be factored in when assessing level of risk.

Since our analysis of media reports also suggests that patients who live in mobile homes are at even greater risk, home type is another element to consider. Whether another person in the household smokes would also be relevant.

WHICH PATIENTS ARE HIGH RISK?



SMOKING COMORBIDITIES AGE TYPE OF HOUSE

CONCLUSION

Firebreaks could have a dramatic impact on patient safety

Home oxygen fires continue to represent a serious public health issue. Beyond the obvious trauma to individual patients and their families, burn-related injuries place a significant financial burden on the US healthcare system each year.

There is mounting evidence from around the world and from local studies in the US that firebreaks can reduce the severity of burns and limit the impact of home oxygen fires. While there is a potential risk of fire for all home oxygen patients, and universal use of firebreaks would be ideal, evidence suggests that installing firebreaks among high-risk patients could significantly reduce the impact of fires. Based on insights from installers and analysis of media reports, 'high risk' would include those who smoke or are thought to smoke, those who are in a household where there are smokers, or those who are in a household with another significant source of ignition.

The medical device industry always works to reduce risk based on evidence, so continuing to improve the evidence base for both the scale and impact of home oxygen fires, and the effectiveness of firebreaks in minimizing that risk, will be crucial.

To find out more about oxygen firebreaks, or any points made in this paper, please contact info@bprmedical.com

References

1. BPR Medical (2019), The prevalence and impact of home oxygen fires in the US, available at: http://www.firebreaks.info/wp-content/uploads/2019/09/BPR-WhitePaper-2019-v6.1.pdf
2. Mastropieri et al. (2020), 18 Stop the Burn: A Smoking and Home Oxygen Safety Initiative with Use of Firebreaks, Journal of Burn Care & Research, 41(1):S15. DOI: https://doi.org/10.1093/jbcr/iraa024.022
3. Paradigm (2018), The High Price of Burn Injuries, available at: https://www.paradigmcorp.com/news/the-high-price-of-burn-injuries/
4. Veterans Health Administration (2018), Patient Safety Alert, available at: https://www.patientsafety.va.gov/docs/alerts/INTERNET_AL18-01.pdf
5. Wolff et al. (2016), Flash Burns While on Home Oxygen Therapy: Tracking Trends and Identifying Areas for Improvement, American Journal of Medical Quality, 32(4):445–452 DOI: https://doi.org/10.1177/1062860616658343
6. Vercruysse and Ingram (2012), A rationale for significant cost savings in patients suffering home oxygen burns: despite many comorbid conditions, only modest care is necessary, Journal of Burn & Care Research, 33(6):e268-74. DOI: https://doi.org/10.1097/BCR.0b013e3182504487
7. Singer. et al. (2020), Mortality From Burns Sustained on Home Oxygen Therapy Exceeds Predicted Mortality, Journal of Burn Care & Research, 41(5):976–980. DOI: https://doi.org/110.1093/jbcr/iraa097
8. Sharma et al. (2015), Burn Injury Associated With Home Oxygen Use in Patients With Chronic Obstructive Pulmonary Disease, Mayo Clinic Proceedings, 90(4):492–499. DOI: https://doi.org/10.1016/j.mayocp.2014.12.024
9. McDonald et al. (2016), Clinical Practice Guideline on Adult Domiciliary Oxygen Therapy: Executive summary from the Thoracic Society of Australia and New Zealand, Respirology, 21(1): 76–78. DOI: https://doi.org/10.1111/resp.12678
10. BPR Medical (2019), Firebreaks Info video, available at: http://www.firebreaks.info/firebreaks-information/
11. BPR Medical (2021), Survey report: US installers (March–June 2021), available at: www.firebreaks.info/wp-content/uploads/2019/09/BPR-WhitePaper-2019-v6.1.pdf

Appendix A

List of home oxygen incidents and fatalities by US State between August 2019 and July 2021

State	Incidents	Fatalities
Alabama	3	2
Alaska	0	0
Arizona	3	2
Arkansas	0	0
California	5	2
Colorado	1	1
Connecticut	3	3
Delaware	0	0
Florida	12	6
Georgia	8	5
Hawaii	0	0
Idaho	4	5
Illinois	10	7
Indiana	11	9
Iowa	4	3
Kansas	6	4
Kentucky	2	1
Louisiana	3	2
Maine	0	0
Maryland	9	4
Massachusetts	5	4
Michigan	12	9
Minnesota	1	0
Mississippi	0	0
Missouri	9	4
Montana	3	1
Nebraska	0	0
Nevada	6	2
New Hampshire	2	2
New Jersey	3	2
New Mexico	7	4
New York	11	8
North Carolina	10	8
North Dakota	0	0
Ohio	14	5
Oklahoma	7	6
Oregon	3	2
Pennsylvania	23	12
Rhode Island	0	0
South Carolina	6	2
South Dakota	0	0
Tennessee	9	6
Texas	12	4
Utah	1	0
Vermont	3	1
Virginia	6	4
Washington	**6**	**5**
West Virginia	**3**	**2**
Wisconsin	**8**	**2**
Wyoming	**2**	**1**
Total	**256**	**152**

Further Information

If you would like to know more about oxygen firebreaks or require clarification on any point in this White Paper, then please contact info@bprmedical.com

BPR Medical

The company has won many awards including a Queen's Award for Innovation in 2012 for its Firesafe™ product range and is currently the world's leading supplier of oxygen firebreaks in medical applications. The team specializes in developing successful long-term partnerships with some of the leading medical gas companies and currently exports to 50 different countries. BPR has developed an enviable reputation by delivering on quality at all levels in the business in line with its Zero Defects goal.

Disclaimer

BPR Medical makes no claim as to the legal or regulatory accuracy of the statements in this report and the reader should not rely on anything contained within it when making commercial or other decisions in relation to its operational policies. BPR Medical strongly recommends that independent legal and regulatory advice is obtained before taking any action.

BPR Medical would welcome contact from any organisation that could help to improve on the body of knowledge on home oxygen fires, with the aim of increasing awareness and transparency of this problem.

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