(DCP4 ID: RESPD04 and 05)
Cluster: Respiratory disorders

Asthma emergency care

Emergency care of severe Asthma (ventilator/BiPAP)

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Description of condition and intervention

Asthma is a non-communicable disease (NCD) which affects both children and adults. It causes inflammation and tightening of muscles around the small airways of muscles due to which the air passage in the lungs becomes narrow. Common symptoms of asthma are: coughing, shortness of breath and chest tightness. Causes of asthma include familial predisposition, specific allergic conditions, exposure to range of environmental allergens etc. Early events of life low birth weight (LBW), prematurity, exposure to tobacco smoke also affects the development of lungs which can lead to asthma. In low-and middle-income countries (LMIC) asthma often remains undiagnosed, and can lead to sleep disturbance, tiredness during the day, and poor concentration among those suffering from it. Around 262 million people were affected by asthma in 2019 which caused 4,61,000 deaths. Most of the deaths occurred in developing countries and are preventable. Source: WHO factsheet 2021, GBD study 2019.

Sustained management with recommended medications can control the disease. GINA (Global Initiative for Asthma) is a stepwise approach in which treatment is escalated and de-escalated

to establish the lowest level of treatment. In the GINA strategy, there are 5 treatment steps. Step 1 is as-needed use of a rapid- and short-acting beta2-agonist (for example, salbutamol) alone. Step 2 is adding the regular low-dose inhaled corticosteroids. Step 3 involves increase in dose of inhaled corticosteroids. Step 4 involves increasing to a medium or high-dose inhaled corticosteroid combined with a long-acting beta2-agonist. In Step 5, alternatives may include a daily dose of oral corticosteroids (adjusted to the lowest dose that maintains freedom from exacerbations and maximal achievable daily freedom from symptoms). For patients experiencing acute exacerbations of asthma or severe asthma, hospitalization at referral-hospital including ventilator or BiPaP intervention may be indicated, depending upon the severity of disease.

Interventions included for asthma emergency care for assessment of their effects and costs for being analysed in FairChoices: DCP Analytical tool are:

Asthma emergency care

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International guidelines

Organization	Indications/recommendations	Applicability in LIC & Lower MIC settings
	Global initiative for asthma	

Intervention attributes

Type of interventions

Curative

Delivery platform

This intervention may be delivered at first-level hospital and at referral hospital (for emergency care with ventilation).

Equity

In addition to considerations like cost-effectiveness and health systems factors, dimensions of equity can be relevant for priority setting. The opportunity for a long and healthy life varies according to the severity of a health condition that individuals might have, so there are inequities in individuals' opportunities for long and healthy lives based on the health conditions they face. Metrics used to estimate the severity of illness at an individual level can be used to help prioritize those with less opportunity for lifetime health. FairChoices: DCP Analytics Tool uses Health adjusted age of death (HAAD), which is a metric that estimates the number of years lived from birth to death, discounting years lived with disability. A high HAAD thus represents a disease less severe in terms of lifetime health loss, while a low HAAD represents a disease that is severe on average, causing early death or a long period of severe disability. It is also possible to estimate the distribution of HAAD across individuals with a health condition. FairChoices shows for each intervention an average HAAD value of the conditions that are affected by respective interventions that have health effects. Additionally, a plot shows HAAD values for around 290 conditions (Johansson KA et al 2020).

Time dependence

High level of urgency. Treatment outcomes highly affected by some hours of delay.

Population in need of interventions

For asthma, the overall mean annual exacerbation rates per patient during the 12-month period after the index date in the US and UK were 0.16/year and 0.11/year, respectively. The average rate therefore being 13.5% (Suruki, 2017).

Treated population for management of asthma are the incident cases of asthma in the age group of 0 to 99 years. The average rate therefore being 13.5%. Furthermore, we estimate 10% of exacerbations are severe enough to consider intubation but of which only a max of 1/3 would require intubation. Therefore, we assume 97% of exacerbations will be managed at first-level hospital as opposed to a referral hospital for 3% asthma exacerbations require ventilation.

Treated fraction needing ventilation is estimated as 13.5%*10% * 1/3 =0.45%. Source: NCD Countdown appendix

Affected population: The affected population is aged 0 to 99 years with the condition, assuming all asthma deaths are due to exacerbations that require referral-level care. About 3% of asthma exacerbations will be managed at referral level hospital (McFadden ER 2003).

Disease state addressed

This intervention targets asthma.

Intervention effect and safety

Table 1: Effect and safety of treatment for asthma emergency care

Effect of intervention		Certainty of evidence
Mortality (due to condition) Inhaled high dose steroid + high dose short-acting beta agonists (SABA)	In a meta-analysis of asthma patients in emergency department setting (Edmonds 2002), patients treated with ICSs were less likely to be admitted to the hospital (odds ratio 0.30; 95% confidence interval [CI] 0.16 to 0.57). For this analysis, we assume hospital admittance as a proxy for mortality. Beta-agonists were not found to significantly impact mortality (Bateman 2008). In a Cochrane review of corticosteroid, patients who were treated with short courses of steroids required significantly less care as defined by relapse within 7 to 10 days (relative risk 0.38, 95% confidence interval [CI] 0.20 to 0.74), fewer hospitalizations (relative risk 0.35, 95% CI 0.13 to 0.95), and less need of β-agonist use (−3.3 activations per day of inhaler; 95% CI −5.6 to −1.0) (Rowe 2007). Using relapse as a proxy for mortality, we assume the efficacy of this intervention to be 62%. Mortality reduction = 0.62*0.97 = 60.1%	See appendix

Emergency care of severe Asthma (ventilator/BiPAP)	In a study (Tomii 2009) of non-invasive ventilation (NIV) in the emergency department for heterogeneous acute respiratory failure, the authors found a relative risk of mortality = 0.51 for NIV when comparing before and after the adoption of the NIV trial strategy. In a meta-analysis (Ram FSF 2004) of COPD exacerbations, non-invasive positive pressure ventilation resulted in decreased mortality, RR= 0.52. However, this is additive to "usual care", so we therefore take the account for the average effect (78%) the acute treatment of asthma/COPD would take on mortality. We therefore calculate the number of deaths that aren't avoided by the acute treatment (1-78%) and multiply that by the effect size for NIV 48.5% to get 10.6%. This is further adjusted as follows (assuming similar effects for asthma): Asthma mortality reduction =10.6%*25%=0.3% (Source: NCD Countdown Appendix)	

Model assumptions

Table 2: Summary of model parameters and values used in FairChoices – DCP Analytical Tool

Category	Model parameter	Notes
Intervention	Asthma emergency care	
Cost parameters		
Treated population	Prevalence of asthma	Global Burden of Disease Study 2019
Gender	Both male & female	
Age	0-99 years	
Treated fraction Asthma emergency care Emergency care of severe Asthma (ventilator/BiPAP)	 0.13095 0.0045	 NCD Countdown appendix NCD Countdown appendix
Effect parameters		
Affected population	Those with condition	

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Affected gender	Both male & female	
Affected fraction age	0 to 99 years	
Affected fraction for mortality outcome Asthma emergency care Emergency care of severe Asthma (ventilator/BiPAP)	 0.13095 0.0045	Same as treated fraction
Comparison	No intervention	
Mortality Reduction (RRR) Asthma emergency care Emergency care of severe Asthma (ventilator/BiPAP)	 0.6014 0.00318	 NCD Countdown Paper NCD Countdown Paper

Intervention cost

The cost for managing acute asthma exacerbations using systemic steroids, inhaled beta-agonists, and, if indicated, oral antibiotics and oxygen therapy is estimated at 195 USD per episode in 2005 in Vietnam using the cost of managing acute COPD exacerbation as a proxy (Hoang Anh PT, et al.). The cost was calculated as a weighted average of hospital and out-patient unit costs. The cost of managing acute ventilatory failure due to acute exacerbations of asthma is estimated to be 272.5892857 pounds per episode in the United Kingdom in 2003. We used the cost of non-invasive ventilation for acute exacerbations of COPD as a proxy as well (Plant P.K. et al). The cost was calculated based on the costs of non-invasive ventilator (£40.393), the cost of replacement masks (£11.75), the additional nursing cost (£4.4464), and the cost of 2 bed days (£216.)

References

Asthma [Internet]. [cited 2021 Sep 5]. Available from: https://www.who.int/news-room/fact-sheets/detail/asthma

IHME. Global Health Metrics. 2019 [cited 2021 Sep 5];396:2020. Available from: www.thelancet.com

Salmeron S, Liard R, Elkharrat D, Muir J-F, Neukirch F, Ellrodt A. Asthma severity and adequacy of management in accident and emergency departments in France: a prospective study. The Lancet 2001; 358: 629–35

McFadden ER Jr. Acute severe asthma. Am J Respir Crit Care Med. 2003 Oct 1;168(7):740-59. doi: 10.1164/rccm.200208-902SO. PMID: 14522812.

Johansson KA, Coates MM, Økland JM, Tsuchiya A, Bukhman G, Norheim OF, Haaland Ø. Health by disease categories. Distributional Cost-Effectiveness Analysis: Quantifying Health Equity Impacts and Trade-Offs. 2020 Sep 30:105.

Edmonds ML, Camargo CA, Pollack CV, Rowe BH. The effectiveness of inhaled corticosteroids in the emergency department treatment of acute asthma: A meta-analysis. Ann Emerg Med 2002; 40: 145–54.

Bateman E, Nelson H, Bousquet J, et al. Meta-analysis: Effects of Adding Salmeterol to Inhaled Corticosteroids on Serious Asthma-Related Events. Ann Intern Med 2008; 149: 33.

Rowe BH, Spooner C, Ducharme F, Bretzlaff J, Bota G. Corticosteroids for preventing relapse following acute exacerbations of asthma. Cochrane Database Syst Rev 2007; published online July 18. DOI:10.1002/14651858.CD000195.pub2.

Tomii K, Seo R, Tachikawa R, et al. Impact of noninvasive ventilation (NIV) trial for various types of acute respiratory failure in the emergency department; decreased mortality and use of the ICU. Respir Med 2009; 103: 67–73.

Ram FSF, Picot J, Lightowler J, Wedzicha JA. Non-invasive positive pressure ventilation for treatment of respiratory failure due to exacerbations of chronic obstructive pulmonary disease. Cochrane Database Syst Rev 2004; : CD004104.

Hoang Anh PT, Thu le T, Ross H, Quynh Anh N, Linh BN, Minh NT. Direct and indirect costs of smoking in Vietnam. Tob Control. 2016 Jan;25(1):96-100. doi: 10.1136/tobaccocontrol-2014-051821. Epub 2014 Dec 15. PMID: 25512430; PMCID: PMC4717360.

Plant PK, Owen JL, Parrott S, Elliott MW. Cost effectiveness of ward based non-invasive ventilation for acute exacerbations of chronic obstructive pulmonary disease: economic analysis of randomised controlled trial. BMJ. 2003 May 3;326(7396):956. doi: 10.1136/bmj.326.7396.956. PMID: 12727767; PMCID: PMC153850.

Appendix

Literature Review for effectiveness & safety

This literature search is an example of Level 1 search for intervention inputs taken from DCP3 or generated in an ad hoc manner (e.g., quick google search found one study of cervical cancer screening cost-effectiveness that was used to create an effectiveness parameter for that intervention).

Level of evidence of efficacy studies:

1. low (expert opinions, case series, reports, low-quality case control studies)
2. moderate (high quality case control studies, low quality cohort studies)
3. high (high quality cohort studies, individual RCTs)
4. very high (multiple RCTs, metaanalysis, systematic review, clinical practice guidelines)