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# Why use CO-verified four-week quit rates as the primary measure of stop smoking service success?

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## Introduction

Four-week quit rates, both self-reported and carbon monoxide (CO)-verified, have been used to evaluate the effectiveness of stop smoking services since their inception in 1999. Although it does not take into account a number of important factors that affect success rates (e.g. level of dependence, age, socio-economic status etc), this measurement does allow for a crude comparison between stop smoking services and within services over time.

The main purpose of this briefing, however, is to review the evidence on the effectiveness of four-week quit rates as a predictor of long-term abstinence versus measurement of quit rates for longer periods following the quit date. This briefing does not cover the evidence on extending behavioural support and treatment to people beyond four weeks, which is covered in a separate NCSCT briefing.

The current standard within the stop smoking services for the assessment of success rates is CO-verified four-week quit rates.[1] A four-week quitter is defined as someone who reports abstinence between weeks two and four from the target quit date, verified by an expired air CO concentration of less than 10ppm (parts per million).[2] By this standard the average success rates of the services in England is 36%.[3] Although the CO threshold and the exact length of follow-up remain a matter of some debate,[4] (guidelines for the evaluation of smoking cessation interventions in clinical trials recommend assessing smoking status at a minimum of six months)[5;6] there are a number of reasons why the current standard constitutes the primary measure of service success.

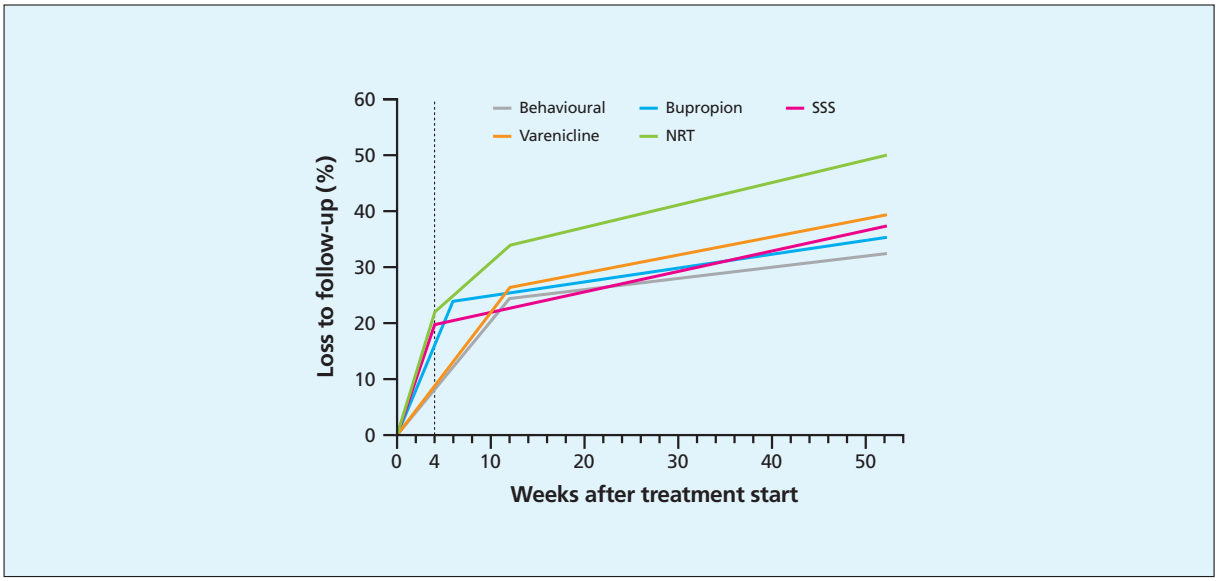
## Decreasing the CO threshold does not improve accuracy

Evidence suggests that reducing the CO threshold below 10ppm does not significantly affect validated quit rates until the threshold goes very low (below 3ppm), at which point there is evidence that this starts to misclassify genuine abstainers.[7] The only exception to the 10ppm threshold is in pregnancy where, in order to avoid missing any women who smoke given the heightened importance of stopping smoking at this time, a lower cut-off point of 4ppm is recommended.[8–10]

## Longer follow-ups result in greater drop-outs and are impracticable

Figure 1 provides estimates of drop out rates (lost-to-follow-up) from a number of research studies examining smoking cessation interventions, including the stop smoking services. The law of attrition suggests that increasing the length of follow-up will increase the rate of drop out.[11] Indeed, drop out is already substantial at four weeks but doubles over longer follow-up periods.

***Figure 1: Loss to follow-up with different treatments***




Note: Data come from representative primary research of smoking cessation treatments;[14–19]
SSS = Stop smoking services (behavioural support + medication); NRT = Nicotine replacement therapy

Although in smoking cessation research drop outs are considered to be people who continue to smoke,[4] introducing such assumptions can result in an underestimation of treatment effects and imprecision, especially when the number of lost-to-follow-up is large.[12] Missing data should, therefore, be minimised if we want to gain a true picture of the effectiveness of stop smoking services. Shorter follow-up (e.g. at four weeks) represents a better way to keep drop out rates low; maintaining adequate longer term follow-up rates is impractical as it is resource-intensive and incurs costs that can otherwise be used for service delivery.[13]

# Why use CO-verified four-week quit rates as the primary measure of stop smoking service success?

## Long-term relapse rates are well established

Years of research have accumulated a wealth of studies which have informed the shape of the relapse curve in smoking cessation which is typically downward sloping and negatively accelerated, common to most survival curves and behaviours.[20;21]

As shown in Figure 2A, and as evidenced by analysis of long-term outcomes of smoking cessation treatment,[22] the trajectory of the relapse curve is typically the same for assisted or unassisted a quit attempts. Figure 2B provides the typical path of unaided quit attempts which, since it is approximate to aided quit attempts in its shape, can be used to predict long-term abstinence rates that are based on relatively short follow-up. Consequently, it can be assumed that the current 36% (CO-validated) smoking cessation success rate at 4 weeks will result in approximately 9% long-term quitters among stop smoking service clients[23] compared with around 3–4% among those who quit unaided.

This is in contrast with the need for longer follow-ups in clinical trials of new treatments and interventions. In such circumstances the typical shape of the relapse curve is not yet known and may differ from the classic shape, therefore longer follow-ups are required to increase accuracy.[24]

***Figure 2A: Survival function for aided and unaided quit attempts***[a]

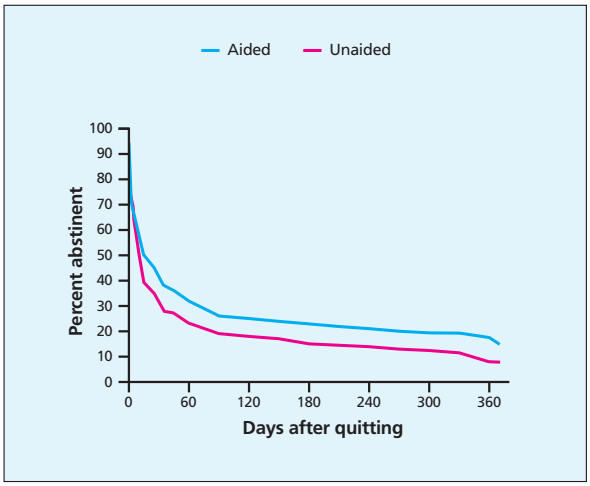
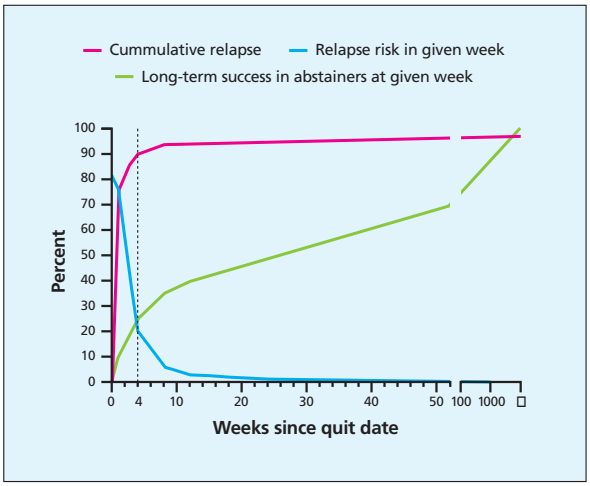



***Figure 2B: Relapse and abstinence during unaided quit attempts***[b]




[a]Data come from Zhu et al[25];

[b]Data approximately based on Hughes et al[26] and West and Stapleton[27]

## Four-week quit rates provide adequate reliability and validity

As shown in Figure 2B, most people relapse within the first couple of days of a serious quit attempt and the prognosis for permanent cessation improves five-fold in the first four weeks.[27] Indeed, only at four weeks follow-up does the weekly risk of relapse drop below the likelihood of being a long-term abstainer.

Based on this information, it is possible to deduce sensitivity (the true positive rate) and specificity (the true negative rate) at different follow-up points. Sensitivity is high across all follow-up assessments insofar as people who will become long-term abstinent will be abstinent from early on and counted as such. The vast majority of lapses turn into relapses and few people recover from an early lapse to become abstinent long-term (see **NCSCT Briefing: The 'not a puff' rule**). Specificity, by contrast, differs across follow-up points as the risk of relapse decreases rapidly, resulting in many of those who relapse not being identified early on but most being correctly identified by four weeks with a specificity above 90% and little improvement thereafter.

Lastly, it is possible to evaluate whether four-week quit rates provide a reasonably accurate measurement of long-term cessation by comparing predictors of both short-term (four-week) and longer-term (one year) cessation in relation to known predictors of quit success.[28] The assumption is that if both short and longer-term follow-ups produce similar predictors which correspond to known predictors of success that they measure the same underlying construct, i.e. long-term cessation. As can be seen in Table 1, there is a large overlap in the predictors of successful abstinence at both short and longer-term follow-up, including the two most reliable predictors of quit success: nicotine dependence and socioeconomic status.[29]

***Table 1: Association of predictors of quit success with abstinence at four and 52 weeks.***

| Predictors | Four-week abstinence[a] | 52-week abstinence[b] |
|---|---|---|
| | Direction of significant association | |
| Low socio-economic status | ↓ | ↓ |
| High nicotine dependence | ↓ | ↓ |
| Older age | ↑ | ↑ |
| Women | ↓ | – |
| Motivation to quit | ↑ | ↑ |
| Poor health status | ↓ | ? |
| Smoke for pleasure | ? | ↑ |

[a]Data come from Judge et al[16]; [b]Data come from Ferguson et al[15]
Note: ? indicates direction is unclear, – indicates absence of significant association

## Conclusion

Four-week CO-validated quit rates represent a reliable and valid indicator of smoking cessation which, based on a large body of research, can be used to predict long-term abstinence rates. Taken together with only modest increases in accuracy for longer follow-ups, but with associated disadvantages in terms of the feasibility and costs of such long-term assessments, the current standard for measuring the abstinence of clients using stop smoking services provides a good balance between accuracy and practicability.

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