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Title: PHYSICIANS' PSYCHOPHYSIOLOGICAL STRESS REACTION IN MEDICAL COMMUNICATION OF BAD NEWS: A CRITICAL LITERATURE REVIEW

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Abstract

Introduction: Stress is a common phenomenon in medical professions. Breaking bad news (BBN) is reported to be a particularly distressing activity for physicians. Traditionally, the stress experienced by physicians when BBN was assessed exclusively using self-reporting. Only recently, the field of difficult physician–patient communication has used physiological assessments to better understand physicians' stress reactions.

Method: This paper's goals are to (a) review current knowledge about the physicians' psychophysiological stress reactions in BBN situations, (b) discuss methodological aspects of these studies and (c) suggest directions for future research.

Results: The seven studies identified all used scenarios with simulated patients but were heterogeneous with regard to other methodological aspects, such as the psychophysiological parameters, time points and durations assessed, comparative settings, and operationalisation of the communication scenarios. Despite this heterogeneity, all the papers reported increases in psychological and/or physiological activation when breaking bad news in comparison to control conditions, such as history taking or breaking good news.

Conclusion: Taken together, the studies reviewed support the hypothesis that BBN is a psychophysiologically arousing and stressful task for medical professionals. However, much remains to be done. We suggest several future directions to advance the field. These include (a) expanding and refining the conceptual framework, (b) extending assessments to include more diverse physiological parameters, (c) exploring the modulatory effects of physicians' personal characteristics (e.g. level of experience), (d) comparing simulated and real-life physician–patient encounters and (e) combining physiological assessment with a discourse analysis of physician–patient communication.

Keywords: physician–patient communication; breaking bad news; stress reaction; psychophysiology; physicians; medical students

1. Introduction[1]

Stress is a widespread phenomenon among healthcare providers. In addition to such common workplace stressors as high workloads, time constraints, the technical complexity of tasks and professionals' conflicting roles, healthcare workers are exposed to the more specific stressors of repeated exposure to illness, suffering, death, the emotional distress of patients, the need to manage their own and patients' negative emotions, and the challenging interactions with patients and their families (Grunfeld et al., 2000; Ruotsalainen et al., 2008; Sehlen et al., 2009). Interpersonal contact and communication is a core element of a physician's activity. Adequate communication has been defined as a key competency for physicians who wish to become medical experts (Frank, 2005). Yet there is evidence that some medical encounters increase physicians' levels of stress. This seems to be especially the case with relatively inexperienced physicians or physicians confronted with challenging communication situations, such as disclosing bad news (e.g. positive cancer or HIV diagnosis, lifelong disablement, event of death) to a patient or a patient's family (Baile et al., 2000; Buckman, 1984; Doyle and O'Connell, 1996). The disclosure of bad news is generally called breaking bad news (BBN). Buckman (1992) broadly defines bad news as "any information which adversely and seriously affects an individual's view of his or her future". Delivering sad, bad and distressing news is a recurrent task, one which healthcare personnel, particularly physicians, have to deal with frequently. Every physician who has direct contact with patients has to break bad news, but this is especially true in medical specialities dealing with life-threatening diseases (e.g. oncology, gynaecology, obstetrics, trauma surgery). Some physicians have to deliver bad news on a daily basis (Baile et al., 2000).

[1] Abbreviations: BBN = breaking bad news; BGN = breaking good news; CO = cardiac output; cs = consultation; DBP = diastolic blood pressure; ECG = electrocardiography; HT = history taking; HR = heart rate; HRV = heart rate variability; MAP = mean arterial pressure; NK = natural killer; POMS = Profile of Mood States; SBP = systolic blood pressure; SC = skin conductance; SP = simulated patient; STAI-S = State-Trait Anxiety Inventory (state scale); SVR = systemic vascular resistance; VAS = visual analogue scale

The scientific literature repeatedly describes BBN as an emotionally burdensome and distressing task—perhaps the most distressing task in a physician's professional activity (e.g. Girgis and Sanson-Fisher, 1995; VandeKieft, 2001; Doyle and O'Connell, 1996; Hulsman et al., 2010). For many years, researchers assessing physicians' stress reactions in BBN situations mainly relied on self-reporting and, indeed, their studies revealed increased self-reported stress and/or anxiety among physicians in these difficult medical encounters. Orlander et al. (2002) described the powerfulness of residents' first clearly-remembered BBN experiences, as revealed by their accounts of the event and their uncomfortable feelings. The intense experiences related to BBN can haunt a physician for decades (Fallowfield, 1993). Even with greater experience, physicians still feel various intensities of stress before and/or during BBN to patients (Ptacek et al., 1999; Ptacek et al., 2001). Ptacek et al. (1999) asked a convenience sample of 38 physicians to recall a BBN consultation and rate, on five-point Likert scales, the level of stress they experienced (from 1 = "none" to 5 = "a great deal") and how long that stress reaction lasted (from 1 = "until the transaction ended" to 5 = "more than 3 days"). Although, on average, the intensity of stress was moderate just prior to and during the delivery of bad news (2.8 ± 1.1 and 3.0 ± 0.9, respectively), the stress experienced lasted longer than the medical encounter itself for 86% of physicians and for more than one day for 20% of them. In another study by Ptacek et al. (2001), 42% of 73 physicians reported that the stress they experienced lasted from several hours up to three days or more. In an informal survey, Baile et al. (2000) found that two thirds of 500 oncologists felt "not very comfortable" or "uncomfortable" dealing with patients' negative emotions. According to Dosanjh et al. (2001), patients' or their families' emotional reactions to bad news seemed to be a source of distress for residents.

Although the assessment of physicians' subjective experiences gives important information on how they feel when breaking bad news, their stress reactions are not limited to this affective dimension: they also manifest themselves on the physiological level. Physiological assessment has some advantages over subjective assessment. When individuals must retrospectively give overall evaluations of their stress during a given time period, particularly stressful moments within this period can either take on a disproportionate importance or be masked. Continuous physiological assessment is much less susceptible to this bias. It can be measured in real-time during the task of interest, does not rely on retrospective judgment and, therefore, allows for a much more fine-grained analysis of particularly stressful moments. The psychophysiological assessment of medical communication is a relatively new area of research, however. Although the use of psychophysiological assessment to investigate physicians' stress reactions in BBN was suggested many years ago (Baile et al., 2000), few studies in the field of BBN in medical communication have used this methodology so far. The present article reviews these papers and aims to:

a) provide an overview of current knowledge on physicians' psychophysiological stress reactions in BBN consultations,
b) discuss the methodological aspects of these studies, and
c) suggest directions for future research.

To date, reviews on BBN have concentrated on various guidelines for BBN (Ptacek and Eberhardt, 1996; Harrison and Walling, 2010), on the effectiveness of communication training for BBN (Rosenbaum et al., 2004) and on cancer patients' preferences regarding the disclosure of bad news (Fujimori and Uchitomi, 2009). The present review is the first to focus on the bearer of bad news and to critically review research on the psychophysiological responses of physicians and medical students during BBN.

2. Methods

We performed a literature research in the Medline and PsychINFO databases using a combination of the keywords "communication", "physician OR doctor", "patient", "bad news", "stress" and "physiolo$". Only studies published before 2017 were considered. In order to be included in the review, studies had to fulfill the following criteria: (a) the population studied consisted of physicians or medical students; (b) the study design was experimental and included at least one condition in which participants had to break bad news to a patient (i.e. BBN scenario); (c) the dependent variables included at least one physiological measure; and (d) the language of publication was English. These criteria returned four studies (Hulsman et al., 2010; Meunier et al., 2013; Shaw et al., 2013; van Dulmen et al., 2007), and a search of their reference lists and citations identified three additional studies relevant to the review (Brown et al., 2009; Cohen et al., 2003; Shaw et al., 2015).

3. Results: Overview of Studies on Physicians' Psychophysiological Reactions to BBN Consultations

The seven studies identified are listed in Table 1, which shows their major sample characteristics. Table 2 provides information on the study assessment scenarios, methods and time points applied, as well as the physiological indicators measured. The seven studies and their main findings are summarised in alphabetical order by first author in the paragraphs below, followed by a comparison of the study results.

The study by **Brown et al.** (2009) aimed to determine whether consultation types were related to physicians' stress responses. Twenty-four physicians participated in two counterbalanced simulation scenarios, i.e. breaking good news (BGN) and BBN. Their physiological stress responses were assessed using heart rate (HR) and measures of heart rate variability (HRV). This study did not assess any self-reported measures of momentary stress. HR was significantly higher and various HRV measures were significantly lower during BBN than during BGN. Furthermore, the authors reported that peaks in HR and HRV measurements during the consultations quickly returned to baseline levels after consultations.

The study by **Cohen et al.** (2003) also aimed to determine whether physicians' stress reactions were different depending on consultation types. They assessed the psychophysiological responses of 25 medical students who had been randomised into one of three situations:

simulated BBN, simulated BGN, or a control reading task. Measurements were made during an initial rest period (baseline), before the task (preparation), during the task (consultation) and after the task (recovery). The dependent variables were: (a) stress, tension, relaxation; (b) mood; and (c) systolic blood pressure (SBP), diastolic blood pressure (DBP), HR and natural killer (NK) cell cytotoxicity. At baseline, the groups were comparable on all the assessed measures. However, the authors reported significantly different reactions for all three groups with regard to the evolution of their mood from baseline to recovery. Positive mood decreased in the BBN group, but remained stable in the BGN group and increased in the control group. The two consultation groups felt significantly less relaxed when breaking the news than the control group did. They also reported higher tension during their tasks than the control group. The same was true for their stress scores. Furthermore, the BBN group showed significantly higher tension and stress than the BGN group. With regard to physiological responses, the BBN group showed significantly higher SBP and HR before the task than the control group. During the task, both the BBN and the BGN groups had significantly higher SBP, DBP and HR than the control group, but they were not significantly different between each other. Additionally, 10 minutes into the task, NK cell function increases were larger in the BBN group than in the control group. All physiological parameters were comparable between groups after the task.

Hulsman et al. (2010) investigated whether the task of communicating with simulated patients was stressful for student physicians and whether their stress responses differed between counterbalanced consultations for history taking (HT) and BBN. Anxiety, stress, HR, mean arterial pressure (MAP), cardiac output (CO) and systemic vascular resistance (SVR) were assessed in 20 medical students. Anxiety was marginally higher before the BBN task than before the HT task. Stress was higher before BBN than before HT, but the difference was not statistically significant. Compared to baseline, HR, MAP and CO increased in both the BBN and HT scenarios. HR and CO were higher, and MAP and SVR were (marginally) lower, in the BBN scenario than in the HT scenario. Furthermore, the investigators found that the order of the consultations influenced psychophysiological stress reactions. Students who performed HT first showed a significant decrease in anxiety from pre- to post-task for both consultations and in stress from pre- to post-task for the BBN consultation. In contrast, they recorded no decrease in anxiety and stress from pre- to post-task for both BBN and HT in students who started with the BBN consultation. Also, the BBN task's impact on cardiovascular measures during the consultation itself was highest when BBN preceded HT, whereas this impact was reduced when HT preceded BBN.

Using two simulated BBN encounters, **Meunier et al.** (2013) investigated the psychophysiological stress responses of 98 residents working with cancer patients. After a baseline assessment, the residents were randomly assigned to a communication skills training group or a waiting list control group. Residents were assessed again after eight months (at the end of the training group's course) for the parameters of self-efficacy (residents' perception of their own ability to communicate with a cancer patient and to manage stress during communication), anxiety and satisfaction with their performance, HR and salivary cortisol. At eight months, the investigators reported a slight-to-moderate decrease in anxiety before and after the simulated task when compared to baseline. This decrease was comparable in both the training and control groups. Thus, training did not influence anxiety levels significantly. However, the training effect was manifest in increased self-efficacy and satisfaction. With regard to HR and cortisol, both groups showed comparable response patterns before training: HR sharply increased at the beginning of the BBN consultation and decreased below baseline levels after the consultation; cortisol levels were comparable before and during the BBN consultation and clearly decreased at the end of the recovery period. Eight months later, the training group exhibited the same HR responses as before training, whereas the untrained group showed lower physiological arousal and had lost the clear peak evident at the beginning of the baseline consultation. The training group showed a significant overall increase in cortisol after eight months in comparison to the situation before the course, whereas the untrained group showed cortisol values identical to baseline.

The study by **Shaw et al.** (2013) aimed to describe physicians' stress responses before and during BBN in comparison to an HT situation but without statistically analysing the differences. Thirty-one medical officers underwent two counterbalanced simulated BBN consultations, with an assessment of self-perceived stress, HR and skin conductance (SC). The investigators found that 90% of participants reported that BBN was "somewhat stressful" to "stressful". They observed an early, anticipatory increase in HR and SC when they started to read the case summary. This peak was followed by three different HR response patterns: a rapid return to near-baseline levels for more than 50% of the physicians; increased HR levels throughout the BBN consultation after a small initial cardiac deceleration for 20% of the physicians; or an initial cardiac acceleration at the beginning of the BBN consultation and levels above baseline throughout it for 10% of the physicians. The authors concluded that about one third of the doctors had shown a significant and sustained stress response. With respect to SC, they also reported three different response patterns after an anticipatory increase: 50% of doctors showed another increase in SC at the end of the preparatory task, remaining over the baseline level throughout the consultation; 30% showed a slight decrease at the end of the preparatory task; and 20% showed a decrease during the consultations, although they all remained above baseline levels throughout the consultations. The investigators also reported a considerable increase in HR and SC around the moment in the consultation that bad news was delivered.

In a subsequent publication involving the same sample, **Shaw et al.** (2015) divided the consultations into pre- and post-delivery phases based on a qualitative analysis of the physician–patient interactions. The decreases in HR (-6.2 bpm) and SC (-1.2 fluctuations/min), from the pre- to the post-delivery phase, were significant. The authors also identified physicians' information delivery styles based on the time needed for BBN (i.e. blunt, forecasting, stalling). Delivery styles had no influence on physiological variables.

Van Dulmen et al. (2007) investigated how carrying out their first ever simulated BBN consultation affected 57 medical students' levels of anxiety, stress, HR, SBP, DBP and salivary cortisol. Cortisol was also measured during a control day. Anxiety, stress, SBP and HR, but not DBP and cortisol, were higher before the consultation than after it. Cortisol levels on waking were not different on the consultation and control days, but they were higher both before and after BBN in comparison to the same moments on the control day.

In summary, all the studies reviewed investigated parameters of physiological stress in medical students and/or physicians participating in simulated BBN consultations. These were mostly measured in combination with subjective affective parameters. All the papers reported increases in psychological and/or physiological activation either before or during BBN in comparison to after BBN or to comparative situations such as BGN or reading aloud. One study (Cohen et al., 2003) reported comparable physiological activation during both BBN and BGN, and it thus concluded that BGN and BBN both produced an acute stress response. This result gives some credence to the idea that (simulated) consultations are stressful *per se*. Nevertheless, the physiological responses before the task were significantly stronger in the BBN group than in the reading aloud control group, whereas the BGN group and reading aloud control group were not significantly different. Also, the psychological response was stronger in the BBN group than in the BGN group, thus also showing that BBN was more stressful than BGN.

HR was the only parameter assessed in all the studies reviewed and is thus the best with which to compare their results. HR was consistently and clearly higher during BBN (on average up to 93 bpm) than both before and after BBN (Hulsman et al., 2010; Meunier et al., 2013). Moreover, HR was higher before a BBN consultation than after one (Cohen et al., 2003; Meunier et al., 2013; van Dulmen et al., 2007). Furthermore, HR was higher before BBN than before a control reading task (Cohen et al., 2003), and increases in HR when reading case histories prior to BBN were also reported (Shaw et al., 2013). HR also clearly showed a higher physiological arousal during BBN consultations than in less stressful situations. More precisely, all the studies that compared HR during BBN consultations found it to be higher than in a comparative communication situation (Brown et al., 2009; Cohen et al., 2003; Hulsman et al., 2010; Shaw et al., 2015; Shaw et al., 2013). Considerable peaks in HR were recorded during the first five minutes of the consultation (Meunier et al., 2013). Shaw et al. (2013) also reported a “considerable change in arousal level after 3.0–3.5 min into the consultations” (p. 205) which corresponded roughly to the very moment of breaking the bad news, clearly the most arousing part of the BBN consultation. The increased physiological activation observed before and during the BBN task seemed to decrease once the bad news had been given (Shaw et al., 2015).

With regard to self-reported measures, a large percentage of physicians evaluated BBN to be *somewhat stressful* to *stressful* (Shaw et al., 2013), with the task eliciting higher self-reported stress before than after the encounter (van Dulmen et al., 2007). This finding was also partially supported by Hulsman et al. (2010). BBN also elicited higher stress and tension levels than control conditions (Cohen et al., 2003). Anxiety seemed to be less of an issue in BBN situations; its scores were rather low (Hulsman et al., 2010; Meunier et al., 2013; van Dulmen et al., 2007). This difference between stress and anxiety may have been due to stress being assessed using a visual analogue scale or a single item directly addressing stress, whereas anxiety was assessed as an overall concept, using a complete questionnaire, i.e. the Spielberger State-Trait Anxiety Inventory (STAI).

Taken together, the studies reviewed support the hypothesis that BBN is a psychohysiologically arousing and stressful task for medical professionals. However, it does not appear to be associated with high levels of anxiety.

Contrary to the homogeneity of the conclusions about BBN’s psychophysiological impact as measured using HR reactivity and self-reported stress and anxiety, the seven studies showed methodological heterogeneity with regard to sample characteristics (e.g. professional experience, sex distribution), the operationalisation of communication scenarios, the order of the consultations, comparative situations and ecological validity, i.e. the resemblance between the experimental setting and real life. Furthermore, the studies assessed different psychophysiological parameters at different time points and over periods of different lengths. These aspects should be taken into account when comparing and interpreting currently available findings about the psychophysiological stress responses of physicians in the field of medical communication of bad news. These issues are addressed and discussed in the following section.

4. Methodological considerations

Sample characteristics. The studies differed with respect to the study groups' professional experience. Three studies were carried out with medical students (Cohen et al., 2003; Hulsman et al., 2010; van Dulmen et al., 2007), three included junior doctors and expert physicians (Brown et al., 2009; Shaw et al., 2013; Shaw et al., 2015) and one involved residents in oncology (Meunier et al., 2013). In the two studies that compared BBN to either BGN or HT, it was not clear whether the students were participating in their first simulated patient (SP) exercise. Either the novelty of the task or a lack of experience could lead to increased demands on concentration and be stressful *per se*, independently of the content of the discussion. Indeed, Cohen et al. (2003) reported similar increases in SBP, DBP and HR for both BBN and BGN simulations. Also, Hulsman et al. (2010) reported greater activation of some cardiovascular variables (HR and CO) in BBN than in HT, whereas other measures (MAP and SVR) were higher in the HT scenario than in BBN. Future studies should therefore give more attention to the role of professional experience. The sex variable also deserves more attention. No study to date has analysed sex differences and only half of them had comparable sex distributions in the study groups (Cohen et al., 2003, Hulsman et al., 2010, Meunier et al., 2013). However, given that the percentage of female medical students in Western countries has been steadily increasing over the last few decades (https://www.aamc.org/members/gwims/statistics/; www.bfs.admin.ch; www.destatis.de) and that there are sex differences in psychophysiological emotional and stress reactions (Kudielka et al., 1998, Gomez et al., 2016), sex is an important factor to consider in this field of research. When making physiological assessments of women, hormonal aspects such as phase in the menstrual cycle, being pre- or post-menopausal, or using hormonal contraception should also be controlled for (Kirschbaum et al., 1999; Symonds et al., 2004).

Operationalisation of communication scenarios. The studies reviewed operationalised BBN and BGN scenarios differently. The content of the BBN scenarios varied between announcing a diagnosis of HIV (Hulsman et al., 2010), a cancer recurrence (Brown et al., 2009), a diagnosis of terminal cancer (Cohen et al., 2003), a breast cancer diagnosis (Meunier et al., 2013), death of close family member (Shaw et al., 2013; Shaw et al., 2015) or was not defined (van Dulmen et al., 2007). Cohen et al. (2003) operationalised BGN as no evidence of cancer, whereas Brown et al. (2009) used degenerative bone disease when a recurrence of cancer was expected. Although much less threatening than a cancer diagnosis, degenerative bone disease may not have been considered as being good news, either by the simulated patient or by the physician. The content of the communication scenarios may well influence the psychophysiological responses of the physicians and the actors and should be well operationalised prior to the study and well defined in the publications.

Order of the consultations. Hulsman et al. (2010) counterbalanced the order of the consultations: one group started with BBN, followed by HT; the other group had the reverse order. Contrary to the expected decrease in anxiety from before to after the consultations, as reported by van Dulmen et al. (2007), Hulsman et al. (2010) did not find this effect in the group that started with the BBN consultation, followed by the HT consultation. It is thus unclear whether the observed effect was indeed due to the order of the scenarios or to the short time interval between the two scenarios leading to contamination effects, especially because participants were kept blind to the types of consultations. After the initial BBN consultation, therefore, stress levels might have remained elevated because students were anticipating another stressful BBN scenario, whereas those who started with the HT consultation showed the normal pattern of heightened arousal before the consultation and decreased arousal after the consultation because they did not expect an ensuing BBN consultation. A future study that wished to compare two communication scenarios and was interested in the preparation and recovery phases of each encounter should keep in mind these potential contamination effects. It might be advisable to carry out the two encounters on two different days.

Comparative scenarios. In addition to a BBN scenario, five studies included comparative scenarios such as HT (Hulsman et al., 2010; Shaw et al., 2013; Shaw et al., 2015) and BGN (Brown et al., 2009; Cohen et al., 2003). This is important, as it makes it possible to determine whether the observed psychophysiological responses in a BBN situation are due to its emotionally difficult content or to the consultation *per se*. It is advisable to use a comparative scenario that uses real communication rather than reading a text aloud and alone where the physician does not need to respond to the patient. Furthermore, when integrating a comparative scenario between two other encounters, researchers should be aware that possible carry-over effects might appear due to the preceding encounter or due to the anticipation of the upcoming encounter, and this might affect the validity of the comparative scenario. Again, therefore, it might be advisable to schedule baseline and/or comparative scenarios on another day or at the beginning of the experiment.

Ecological validity. None of the studies reviewed used real physician–patient encounters: all BBN consultations were simulated. For research purposes, this has certain advantages: simulated scenarios make it possible to highly standardise the encounter with respect to the role of the SP, his/her behaviour and the schedule of encounters. Furthermore, audio and video recording, which raise fundamental ethical issues in real-life, are feasible in simulations. Although simulated settings are often criticised, various authors have argued for their validity: SPs have been found to prove highly authentic, with physicians and medical students unable to determine whether patients were real or simulated (Norman et al., 1982; Sanson-Fisher and

Poole, 1980) and with students showing comparable levels of empathy with real and simulated patients (Sanson-Fisher and Poole, 1980). Furthermore, simulated settings have also been shown to be valid means of studying communication style (Kidd et al., 2005) and they can be considered as valid, accurate teaching and assessment tools (Barrows, 1993; Rethans, 1998; Wakefield et al., 2003). Finally, the studies reviewed revealed that simulated BBN scenarios were actually able to elicit a stress reaction on a psychophysiological level.

Heterogeneity of assessed parameters. Physiological arousal in BBN consultations was assessed using diverse parameters including cardiovascular variables, salivary cortisol, SC and NK cell cytotoxicity. Also, for the subjective experience of stress, the studies used heterogeneous items and questionnaires, such as the short and standard forms of the STAI-S (Spielberger, 1983), the Profile of Mood Scales (POMS) (McNair, 1971) and visual analogue scales (VAS) for rating stress. The only variable which was assessed in all studies and allowed for direct comparison was HR.

Heterogeneity of assessment time points and duration. BBN scenarios differed between studies, not only in their parameters but also in their assessment periods and durations. As a whole, the acute stress response comprises the anticipatory stress response, actual exposure and recovery from the stressor. Only three studies assessed psychophysiological parameters in each of these periods (Cohen et al., 2003; Meunier et al., 2013; Shaw et al., 2013). The other studies only made their assessments during the consultation (Brown et al., 2009; Shaw et al., 2015), before and after the consultation (van Dulmen et al., 2007), or before and during the consultation (Hulsman et al., 2010). Four studies investigated the continuous evolution of HR over time, whether quantitatively or qualitatively (Meunier et al., 2013; Shaw et al., 2013; Brown et al., 2009; Shaw et al., 2015). Differences in the duration of assessments might also have influenced their reported findings. Given that psychophysiological arousal seems to be highest at the beginning of the BBN consultation (Brown et al., 2009; Meunier et al., 2013; Shaw et al., 2015), the initial peak in HR might be lost in studies only reporting results from the last minutes of a consultation, thereby underestimating the physiological stress reaction. Studies assessing physiological responses at regular intervals, instead of making a continuous assessment, may be subject to the same bias.

Inclusion/exclusion criteria. Only three studies reported inclusion/exclusion criteria (Brown et al., 2009; Cohen et al., 2003; Shaw et al., 2013), mentioning that participants had to be in good physical and/or mental health. Whereas two studies excluded participants taking medication likely to affect cardiovascular function (Brown et al., 2009) or the immune system (Cohen et al., 2003), 10% of the physicians in Shaw et al.'s (2013) sample used medication known to affect cardiac function, but this factor was not controlled for. The reported HR might, therefore, have been underestimated. Meunier et al. (2013) did not explicitly report medication intake but controlled for it in their statistical analyses. Two studies mentioned no exclusion criteria (Hulsman et al., 2010; van Dulmen et al., 2007). Medication with the potential to influence the parameters of interest should be controlled for in order to avoid confounder effects in the results and their interpretation.

5. *Future directions*

In light of the existing literature on the psychophysiological response in BBN encounters, discussed above, we will now suggest some possible avenues for future research that we believe to be important to the expansion of knowledge in this field.

5.1. Expanding the conceptual framework in psychophysiological research on BBN

To date, psychophysiological studies of BBN encounters have captured physicians' psychological experiences in terms of a few, almost exclusively negatively valenced, affective phenomena. Except for Cohen et al. (2003) and Meunier et al. (2013), determining physicians' experiences when breaking bad news has been limited to assessments of anxiety and stress. Although physicians' experience of anxious and stressful states is undeniably important, we believe that psychophysiological research in the context of physician–patient encounters could benefit from more diverse, comprehensive and fine-grained approaches. Here, we suggest four such approaches.

Cognitive appraisal is central to the generation and modulation of affective states (e.g. Barrett, 2006). When confronted with an active task, such as BBN, appraisals of situational demands and appraisals of available coping resources interact with each other to determine our affective response. According to the biopsychosocial model of challenge and threat (Blascovich, 2008; Seery, 2013), challenge states manifest themselves when evaluated personal resources in a motivated performance situation exceed evaluated situational demands, whereas threat states arise when evaluations of demands exceed evaluations of resources. This model also makes predictions about physiological arousal. Specifically, although both states are accompanied by increased activation of the sympathetic nervous system, challenge states would be mainly characterised by increased CO, whereas threat states would be reflected in enhanced vascular constriction (Blascovich, 2008; Seery, 2013). Thus, during challenge, arteries are more dilated/less constricted than during threat, which facilitates the heart pumping relatively more blood. Challenge and threat states are best captured by a cardiovascular challenge/threat index defined as the sum of CO reactivity and reverse-scored SVR reactivity—larger values corresponding to greater challenge (Blascovich et al., 2004; Moore et al., 2012; Turner et al., 2012). Hulsman et al. (2010) assessed CO and SVR using the volume-clamp method. However, their study was not framed within the biopsychosocial model of challenge and threat, and their analytical approach does not allow their results to be easily interpreted from the challenge/threat perspective. Future studies in the field of BBN might benefit from an analysis of the cardiovascular challenge/threat index as an objective way of differentiating physicians' responses in terms of challenge and threat states. Preferably, this cardiovascular index would be obtained using impedance cardiography, electrocardiography and beat-to-beat blood pressure recordings (Shapiro et al., 1996; Sherwood et al., 1990). The index could be complemented with questionnaires assessing physicians' subjective evaluations of their personal resources and task demands (Mendes et al., 2007; Jamieson et al., 2016), as was also suggested by Hulsman et al. (2010). Moreover, most studies have shown that individuals exhibiting a cardiovascular challenge pattern perform better than individuals exhibiting a cardiovascular threat pattern in various types of task (e.g., Blascovich et al., 2004; Jamieson et al., 2016; Mendes et al., 2007; Moore et al., 2012; Turner et al., 2012). Whether this is also true in the context of a complex task such as BBN is an intriguing question that would be important to address in future research.

Distinct negative (e.g. anger, fear, shame) and positive (e.g. happiness, gratitude, pride) states often differentially impact on cognition and behaviour, even when of the same valence (Keltner and Lerner, 2010; Loewenstein and Lerner, 2003). Therefore, as advocated by DeSteno et al. (2013), a differentiated approach, focusing on specific emotions, is likely to greatly inform our understanding of the affect–health relationship. Physicians probably experience a greater range of emotions than just anxiety or stress which are traditionally assessed. Indeed, because of the physician–patient interaction's social nature, investigating the above-mentioned emotional states should be an important part of any future work.

Studies by Ptacek and colleagues (Ptacek and Eberhardt, 1996; Ptacek et al., 1999), using retrospective self-reporting, have provided evidence that a considerable proportion of physicians feel that BBN encounters have psychological effects that extend beyond the few minutes preceding and following the physician–patient interaction, i.e. BBN encounters appear to have prolonged effects. Future research should exploit the remarkable technological and methodological advances in ambulatory assessment and explore these prolonged effects through a combination of self-reporting, behavioural records and physiological measurements as physicians carry out their normal daily activities. Such research could be embedded in theoretical frameworks of stress that link psychosocial stressors, cognition, physiological changes and health, such as the perseverative cognition hypothesis (Brosschot et al., 2010). According to this hypothesis, stress-related health problems are not due to psychophysiological activation during stressful events, but rather to perseverative cognition, i.e., the repetitive or sustained activation of cognitive representations of past stressors (typically in the form of rumination) or of anticipated stressors (typically in the form of worry). Perseverative cognition prolongs physiological activation (e.g., cardiovascular, endocrine) beyond the presence of actual stressful situations, thus, adding to the total load that stressful events have on somatic well-being. This prolonged physiological activation eventually leads to a pathological state and somatic problems.

Difficult BBN encounters may be one of these situations, bothering physicians for long time periods and potentially contributing to exhaustion. Closely related models have been developed in the more specific domain of occupational psychology. These highlight the phenomena of "work-related affective rumination" and "psychological detachment from work" as crucial contributors to workers' well-being, health and performance (Querstret and Cropley, 2012; Sonnentag and Fritz, 2015). These are concepts on which future work on physician–patient interactions could build in order to study the prolonged psychophysiological effects of BBN.

Finally, all the studies reviewed in this paper used explicit measures of affect. Self-reported measures for the assessment of affect rely on the subject's introspective ability and can thus be biased by social desirability and self-delusion. Recent research has provided instruments such as the Implicit Positive and Negative Affect Test, which allows an assessment of implicit affect (Quirin and Bode, 2014). Indeed, there is accumulating evidence that implicit affect may be a better predictor of physiological responses to stressors than measures of explicit affect (Quirin et al., 2009).

5.2. Extending physiological assessment

Studies of physicians' psychophysiological responses in the context of BBN interactions have assessed cardiovascular parameters, salivary cortisol, SC and NK cell cytotoxicity. Future research could benefit from adding other indices of physiological alterations. We suggest salivary alpha-amylase and respiration. Interest in using salivary alpha-amylase as an indicator of stress-related changes in autonomic activity has grown recently because its secretion is regulated by the autonomic nervous system (Nater and Rohleder, 2009). Salivary alpha-amylase has also been found to correlate highly with reports of state anxiety (e.g. Noto et al., 2005) and to increase in response to psychosocial stressors (Ditzen et al., 2014; Thoma et al., 2012). Alpha-amylase and cortisol can be determined from the same salivary sample and, therefore, this represents a convenient opportunity to more comprehensively evaluate the psychophysiological responses to potential stressors. Despite the widespread physiological and psychological causes and effects of breathing (dys)regulation (e.g. Vlemincx et al., 2013a; Courtney, 2009; Ramirez, 2014), respiration remains an understudied system in psychophysiological research. Recent studies have provided evidence that the negative emotional states that physicians in BBN situations are likely to experience, such as anticipatory anxiety and worry, are associated with specific respiratory alterations (Studer et al., 2012; Vlemincx et al., 2013b).

5.3. Investigating experience with BBN situations and other individual characteristics

Most studies of difficult physician–patient interactions have focussed on students who had very little experience of BBN situations. No studies have yet compared the psychophysiological stress reactions of medical students with those of experienced physicians in order to control for this factor. Brown et al. (2009) compared the psychophysiological stress reactions of two groups distinguished by their years of professional experience, i.e. novice doctors and experts. These authors reported significant differences between the two groups for two out of eight HRV indicators. Future research should compare the responses of students and experienced physicians in order to evaluate whether their psychophysiological responses are comparable. Studies could also benefit from considering other individual characteristics, such as personality traits (e.g. neuroticism).

5.4. Comparing simulated and real encounters

To the best of our knowledge, there have been no comparisons of physicians' psychophysiological responses to simulated and real medical encounters. To date, all the psychophysiological studies on BBN have been carried out using simulations. The only psychophysiological study of real-life physician–patient communications involved HT in ambulatory and in-hospital consultations, and it did not take into account BBN (Pottier et al., 2011). The focus on simulations is mainly due to ethical and logistical issues. It thus seems important to mention that modern ambulatory measurement devices enable the investigation of physicians' physiological responses in real-life settings, almost without the patient's knowledge and without violating any ethical principles. Given that there have been no comparison studies between real and simulated settings, it is not yet even clear whether physicians' psychophysiological responses in these settings are comparable. Being able to show physiological associations between simulated and real settings would give additional support to the use of simulated settings in research and teaching.

5.5. Evaluating the training effects in BBN settings

Although Baile et al. (2000) first suggested using physiological assessment to validate their communication protocol, widely used in the field of BBN, over 15 years ago, only one study to date has used this methodology to evaluate the effectiveness of communication skills training (Meunier et al., 2013). These authors hypothesised that the higher physiological activation in trained participants than in untrained participants, as observed during BBN tasks shortly after training courses, may have been due to the increased mental effort and increased engagement with the task instilled in training in order to respond adequately to this complex task. To confirm this hypothesis in the future, psychophysiological activation should not only be assessed immediately after a training course but also over the longer term (i.e. weeks to months after training) when less mental effort would be needed for good communication. The increased psychophysiological arousal in trained medical staff might also be due to the fact that (a) they want to meet their own higher performance expectations or (b) their newly learnt competencies are being evaluated by experts. This situation might represent either a challenge or a threat for the trained physicians. To confirm the hypothesis of perceived challenge, the biopsychosocial model of challenge and threat should be applied to a BBN setting.

Senior hospital doctors acknowledged that inadequate training in communication skills was a major determinant in the high prevalence rates for burn-out and psychological morbidity among physicians (Ramirez et al., 1996). This shows the importance of developing adequate communication skills for BBN in medical students and physicians. It has yet to be decided which kind of training would be most suitable to decrease the perceived demands on physicians and to increase their perceived resources in order to provide them with practical support in difficult communication situations, prevent negative effects on their health and well-being and concomitantly increase the quality of care.

5.6. Linking psychophysiology and discourse analysis

Meunier et al. (2013) reported that the improvements visible after communication training seemed to be much more to do with the technical aspects of communication (open questions, information giving, etc.) than the relational aspects (empathy, acknowledgement). Future studies should assess whether relational aspects are more strongly associated with physiological responses than with technical communication issues. Future research linking psychophysiology and discourse analysis might prove a very fruitful means with which to better understand precise extracts from communications. Both methodologies could be used to identify specific incidents. More specifically, one could start identifying communication sequences where the physician or patient is in a high state of psychophysiological arousal, and then use discourse analysis to help understand the physiological manifestations measured. Alternatively, one could start from a discourse analysis perspective, to identify particularly salient moments during the encounter (such as talking about fear or despair, or the patient crying), and psychophysiology could then be applied in order to see what happens on the physiological level. In this respect, it might be interesting to investigate whether there is a physiological component to empathy and whether the physician's expressions of empathy are synchronised with the physiological responses occurring between the physician and the patient (Kelava et al., 2014; Marci and Orr, 2006).

6. Conclusion

Physiological assessment is a relatively new methodology in the field of difficult physician–patient communication. Based on the literature reviewed, a mere seven studies have used it to investigate the stress reactions of physicians and medical students in BBN scenarios. All the authors of the papers reviewed concluded that BBN was a stressful task, as shown by higher levels of psychological and/or physiological response before or during BBN than after BBN or in comparison to scenarios such as BGN or reading aloud. Cohen et al. (2003) concluded that simulated physician–patient communication—for BGN, but particularly for BBN—is a relatively realistic stressor, able to produce both psychological and physiological changes. These authors put forward the view that "if there is support in a naturalistic clinical setting that delivering bad medical news causes more psychological distress and physiological changes than other types of medical encounters, this suggests that health-care providers who frequently have these encounters may develop more health problems over time and may have an increased rate of job burnout" (p. 469). We stress once more that it will be important to determine whether results from simulated settings are comparable to the psychophysiological reactions in real physician–patient encounters and whether experienced physicians and medical students exhibit comparable psychophysiological stress reactions. If they do, communication skills training specifically tailored to physicians' needs might be a valuable tool with which to help them handle difficult communication situations more effectively. Given that communication skills training consumes valuable resources of time and money, a rigorous evaluation of the effectiveness of training is crucial. Effectiveness should be evaluated on the basis of various aspects, such as changes in the subjective perception of difficult situations (e.g. increased confidence and satisfaction, a shift from threat to challenge state) or improvements in the quality of the physician-patient communication and patients' care. The role of objective physiological stress responses as indicators of a training course's effectiveness remains to be determined.

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Compliance with ethical standards: The authors of all the studies reviewed for this publication stated that they had been approved by the competent ethics committee.

Informed consent: The authors of six of the seven studies reviewed explicitly stated that informed consent was obtained from all participants (Cohen et al., 2003; Hulsman et al., 2010; Meunier et al., 2013; Shaw et al., 2013; Shaw et al. 2015; van Dulmen et al., 2007). The authors of the seventh study did not address informed consent explicitly but stated that they had conducted their study “with full approval from the human research ethics committee of the University of New England” (Brown et al., 2009).

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Table 1: Sample characteristics of the reviewed studies

Authors (year)	Sample	n	Age (M ± SD)	Sex (% female)	Origin
Brown et al. (2009)	Novice doctors (interns or residents with 1–3 years' experience)	12	29 ± 6 (novices)	58	Australia
	Expert doctors (> 4 years' experience)	12	42 ± 8 (experts)	25	
Cohen et al. (2003)	Medical students (3rd or 4th year)	25	27.1 ± 1.8	40	US
Hulsman et al. (2010)	Medical students (4th or 5th year)	20	NA	50	The Netherlands
Meunier et al. (2013)	Residents (trained in communication)	50	28.0 ± 3.0	68	Belgium
	Residents (untrained in communication)	48	28.0 ± 2.1	60	
	(mean years of residency: 3.0 (SD = 1.3))				
Shaw et al. (2013)	Junior medical officers (interns and residents)	9	36.6 ± 11.2	32	Australia
	Senior medical officers	22			
Shaw et al. (2015)	Same sample as in Shaw et al. (2013)				
van Dulmen et al. (2007)	Medical students (2nd year)	57	NA	84	The Netherlands

Notes: NA "not available"

Table 2: Study assessment scenarios, methods and time points, as well as the physiological indicators measured

Authors (year)	Scenarios	Measures	Assessment method	Assessment time points
Brown et al. (2009)	between-subject design BBN: cancer recurrence BGN: degenerative bone disease	HR, HRV	ECG	5-min epoch during each scenario
Cohen et al. (2003)	between-subject design Control reading task BBN: diagnosis of terminal cancer BGN: no evidence of cancer	Stress, tension, relaxation	1-item scales	during task[a] (retrospectively)
		Total mood disturbance	POMS	at baseline and completion of the task
		SBP, DBP, HR	Self-inflating blood pressure cuff	at rest (30 min), before, during and after task (at 2-min or 5-min intervals)[b]
		NK cell toxicity	Blood sampling	at start and end of rest period, 5 min after start and end of task and 30 min after end of task
Hulsman et al. (2010)	within-subject design HT BBN: HIV diagnosis	Anxiety	STAI-S (short version)[c]	immediately before and after cs
		Stress	VAS	immediately before and after cs
		HR, MAP, CO, SVR	Volume-clamp method (finger cuff)	at rest (1 min), reading aloud (1 min), during (last 5 min of cs)
Meunier et al. (2013)	between-subject design BBN: breast cancer diagnosis	Anxiety	STAI-S	immediately before and after cs
		Self-efficacy	Parle et al.'s scale (adapted)[d]	at rest (before cs)
		Satisfaction	VAS	after cs
		HR	ECG	at rest (30 min), before (10 min), during (20 min) and after cs (10 min)
		Cortisol	Saliva sampling	10 min before cs, immediately before cs and 0, 10 and 30 min after cs

[a] "Task" meaning BBN, BGN or control reading

[b] The mean of three (rest, preparation), four (recovery) and seven (consultation) physiological readings assessed at 2-min intervals (preparation, consultation) or 5-min intervals (rest, recovery) were considered.

[c] MARTEAU, T. M. & BEKKER, H. 1992. The development of a six-item short-form of the state scale of the Spielberger State-Trait Anxiety Inventory (STAI). *Br J Clin Psychol,* 31**,** 301-6.

[d] PARLE, M., MAGUIRE, P. & HEAVEN, C. 1997. The development of a training model to improve health professionals' skills, self-efficacy and outcome expectancies when communicating with cancer patients. *Soc Sci Med,* 44**,** 231-40.

Table 2 (continued)

Authors (year)	Scenarios	Measures	Assessment method	Assessment time points
Shaw et al. (2013)	within- and between-subject design HT: as control condition for speech influence on breathing BBN 1: death of husband BBN 2: death of mother	Stress HR SC	1-item scale ECG Ag-AgCl electrodes attached to the non-dominant hand	after cs (rated retrospectively) before cs (variable duration) and ~ 10 min during cs (30-s epochs) before cs (variable duration) and ~ 10 min during cs (30-s epochs)
Shaw et al. (2015)	within- and between-subject design as in Shaw et al. (2013)	HR SC	ECG Ag-AgCl electrodes attached to the non-dominant hand	~ 10 min during cs (30-s epochs) ~ 10 min during cs (30-s epochs) cs was divided into pre- and post-delivery phases based on a qualitative analysis of the physician–patient interaction
van Dulmen et al. (2007)	within-subject design BBN: not specified	Anxiety Stress HR, SBP, DBP Cortisol	STAI-S VAS Wrist monitor Saliva sampling	at 5 min before cs and 10 min after cs at 5 min before cs and 10 min after cs at 5 min before cs and 10 min after cs directly after waking, 5 min before cs, 10 min after cs on the cs day and at the same time on a control day

Notes: cs = consultation

Title: PHYSICIANS' PSYCHOPHYSIOLOGICAL STRESS REACTION IN MEDICAL COMMUNICATION OF BAD NEWS: A CRITICAL LITERATURE REVIEW

Highlights :

- Studies on physicians' psychophysiological stress when breaking bad news are reviewed
- Physicians show increased psychopsychological activation when breaking bad news
- Breaking bad news is an arousing and stressful task in the medical profession
- Future directions to advance the field are discussed