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Intra-aortic balloon pump: is the technique really outdated?

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Abstract

Aims Intra-aortic balloon pump (IABP) utilization was expected to be quickly abandoned following the IABP-shock trial and its class III, level B recommendation in the 2016 European Society of Cardiology (ESC) guidelines. The aim of this study was to evaluate the use of IABP compared with other mechanical support devices in a nationwide approach.

Methods and results We conducted a retrospective study based on the French national hospital discharge database. All patients undergoing assist device implantation by IABP, extracorporeal membrane oxygenation (ECMO), or IMPELLA[®] from 2014 to 2018 (2 years before/2 years after the 2016 guidelines) were included. The primary endpoint was the incidence of IABP implantation over the years. Secondary endpoints were incidence of total assist device, ECMO, and IMPELLA[®] implantations. From 2014 to 2018, a total of 18 940 patients benefited from mechanical support by IABP ($n = 6657$, 35.2%), ECMO ($n = 11 881$, 62.7%), or IMPELLA[®] ($n = 402$, 2.1%) in France. The incidence of total mechanical support implantations (ECMO and IABP) was constant over the years. IABP implantations decreased progressively from 1725 implantations in 2014 to 996 in 2018 (−42%). By contrast, ECMO implantations increased progressively from 1919 implantations in 2014 to 2763 implantations in 2018 (+44%). IMPELLA[®] implantations remained stable over the years from 63 (1.7%) implantations in 2014 to 83 (2.1%) in 2018.

Conclusions In this nationwide real-life study, despite a significant decline in IABP implantations over the years since the ESC guidelines, this device remained used in clinical practice with around 1000 implantations in 2018. The size of centres was not strictly correlated with this use, suggesting differential uses depending on the local background.

Keywords Intra-aortic balloon pump (IABP); Mechanical support; Cardiogenic shock; Extracorporeal membrane oxygenation (ECMO)

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Introduction

Cardiogenic shock (CS) is still associated with a high rate of mortality (30–50%) despite improvements in therapies.¹ In this situation, short-term mechanical support, in addition to vasoactive agents, may improve systemic perfusion allowing cardiac recovery. Among mechanical support, intra-aortic balloon pump (IABP), had been widely used for 50 years especially in acute ischaemic setting.² However, the level of recommendation of routine intra-aortic balloon

pump (IABP) in the case of cardiogenic shock (CS) decreased from class I, level C to class III, level B in the 2016 European Society of Cardiology (ESC) guidelines, following the IABP-shock trial, because its efficacy had been questioned.^{3,4} IABP utilization was then expected to decrease dramatically.

The aim of this study was to evaluate the utilization of IABP compared with other devices in a nationwide approach. Our hypothesis was a dramatic decrease when comparing 2014–2016/2016–2018.

Methods

We conducted a retrospective study based on the French national hospital discharge database. All patients who underwent assist device implantation by either IABP or extracorporeal membrane oxygenation (ECMO) from 2014 to 2018 (2 years before/2 years after the 2016 guidelines) were included. The primary endpoint was the incidence of IABP implantations over the years. Secondary endpoints were incidence of total assist device implantations and ECMO implantation.

IABP, ECMO, and IMPELLA® are described here despite the underuse of IMPELLA® in France until now because it is not reimbursable. Data concerning clinical characteristics and medical history were not available. To better understand the evolutions of use of these devices, the centres have been divided following (i) the presence or not of cardiac surgery, (ii) the level of activity of interventional cardiology (quartiles), and (iii) the size of centres in terms of beds (quartiles).

The investigation conforms with the principles outlined in the *Declaration of Helsinki*.

Results

From 2014 to 2018, a total of 18 940 patients benefited from mechanical support by IABP ($n = 6657$, 35.2%), ECMO ($n = 11 881$, 62.7%), or IMPELLA® ($n = 402$, 2.1%) in France. The proportion of total mechanical support yearly was

constant with 3707 (19.6%) device implantations in 2014, 3792 (20.1%) in 2015, 3838 (20.3%) in 2016, 3761 (19.9%) in 2017, and 3842 (20.2%) in 2018.

From 2014 to 2018, incidence of IABP implantations decreased from 1725 (46.5% of mechanical support in 2014) to 996 (25.9% of mechanical support in 2018) with a 42% of decrease in IABP implantations within this period. Conversely, ECMO implantations increased from 1919 implantations (51.8% of mechanical support) in 2014 to 2715 implantations in 2018 (71.9% of mechanical support), with a 42% of increase in ECMO implantations within this period. IMPELLA® implantations remained very low and stable over the years from 63 (1.7%) implantations in 2014 to 83 (2.1%) in 2018 (*Figure 1*).

These evolutions can be described following the size and activities of centres. This increase of ECMO implantations was mainly due to large centres with cardiac surgery (*Figure 2*). Nevertheless, these centres were users of IABP too. Both centres with high-level activities (Quartiles 3 and 4) or low-level activities (Quartiles 1 and 2) in terms of interventional cardiology used IABP (*Figure 3*). However, large centres in terms of beds (Quartiles 3 and 4) presented a strong decrease by contrast with stable IABP use in small-sized or medium-sized centres (Quartiles 1 and 2) (*Figure 4*).

Discussion

In this real-life nationwide study, five main results were highlighted:

Figure 1 Incidence of IABP, ECMO, and IMPELLA® implantations yearly. Total IABP, ECMO, and IMPELLA® implantations in 2014, 2015, 2016, 2017, and 2018 in France. ECMO, extracorporeal membrane oxygenation; IABP, intra-aortic balloon pump.

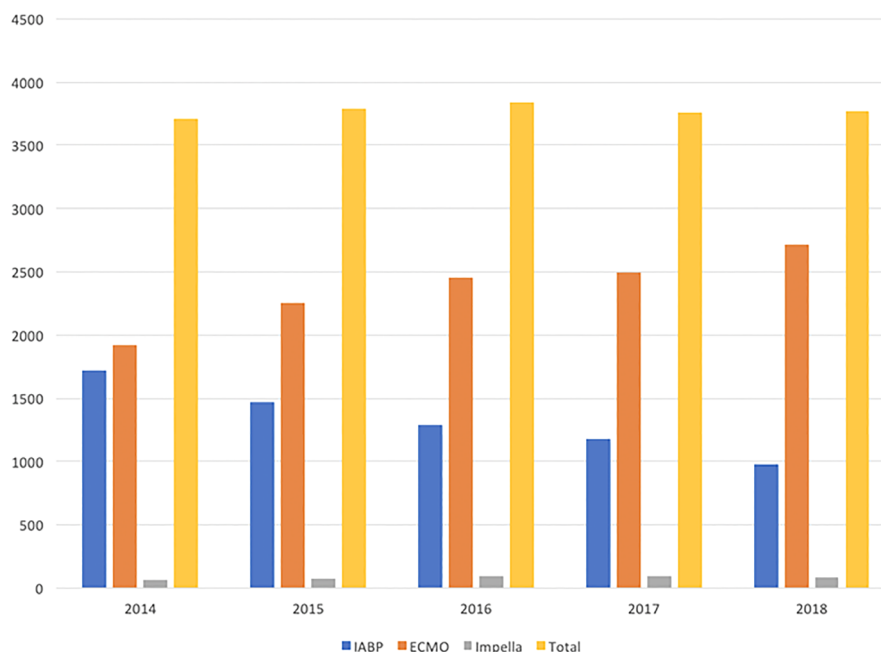
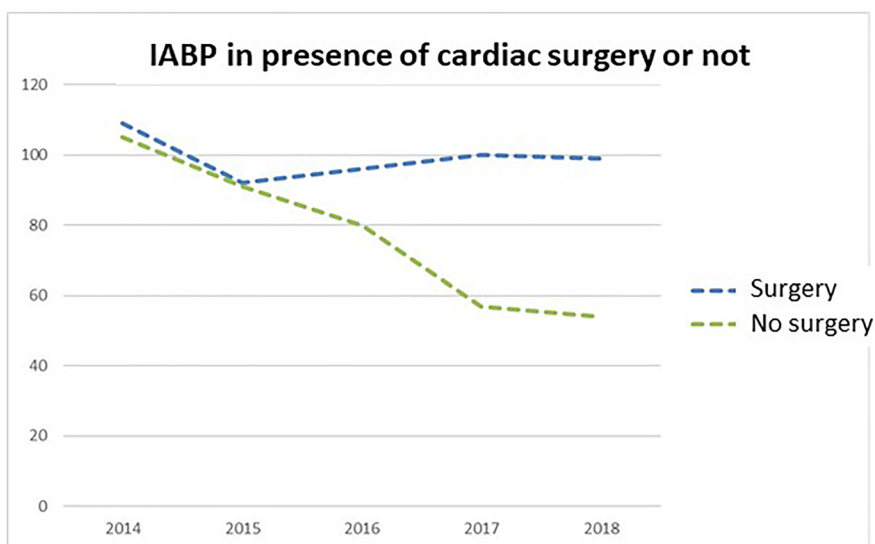
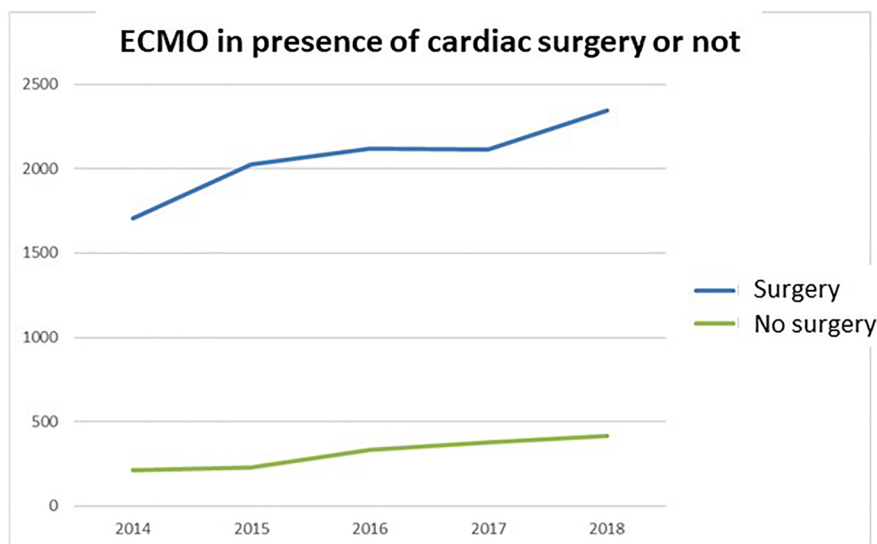
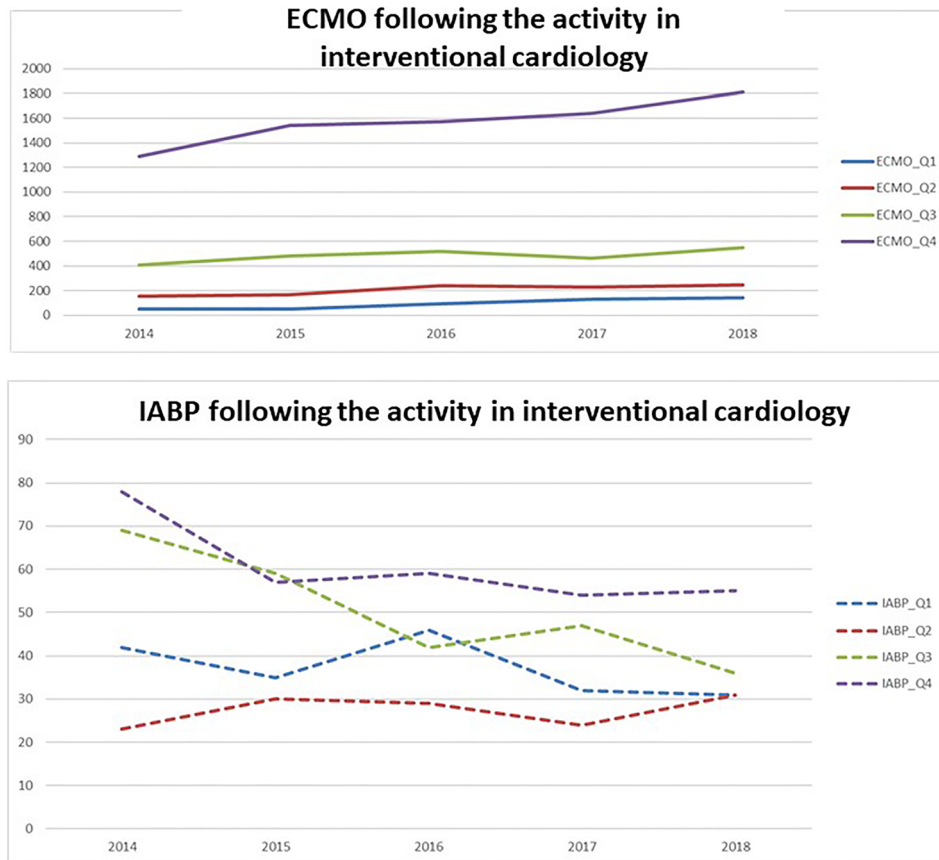


Figure 2 ECMO and IABP implantations according to the presence or not of onsite cardiac surgery. ECMO, extracorporeal membrane oxygenation; IABP, intra-aortic balloon pump.



- (1) IABP insertion decreased over the 5 past years but with a still wide utilization despite recent downgrading in ESC guidelines.
 - (2) Incidence of mechanical support implantations was constant yearly as IABP was supplanted by ECMO with a significant increase in ECMO implantations over the years.
 - (3) This increase was homogeneous in centres independent of the size of the centres, although ECMO was by far more used in centres with cardiac surgery and/or interventional cardiology.
 - (4) IABP was by contrast more used in small centres (when considering the numbers of beds but not specifically the interventional cardiology activity).
 - (5) IMPELLA® was used in a small number of patients, stable over the years.
- The decrease in IABP implantations observed referred to the recent downgrading in the ESC guidelines for systematic IABP implantation in cardiogenic shock.³ However, IABP is still widely used with nearly 1000 implantations in 2018 nationwide for many reasons. First, many centres may have no access to others mechanical support. IABP remains easy, fast, and safe to place. It can be inserted by a cardiologist, an intensivist, or a surgeon. All these reasons may explain the stability of IABP use in smaller centres in our study where IABP may be the most available mechanical device.

Figure 3 ECMO and IABP implantations according to the activity in interventional cardiology. The activity in interventional cardiology was divided into four quartiles, with Q1 as the smaller quartile of activity and Q4 as the most important. ECMO, extracorporeal membrane oxygenation; IABP, intra-aortic balloon pump.



Second, some indications may be relevant for IABP implantation in CS. Indeed, mechanical complications of myocardial infarction such as ventricular septal defect or mitral regurgitation are well-known although relatively rare indications for IABP implantation.^{5,6} Above all, this technique is cost-effective, simple, and feasible in all centres. Moreover, complications are rare after IABP in comparison with ECMO.

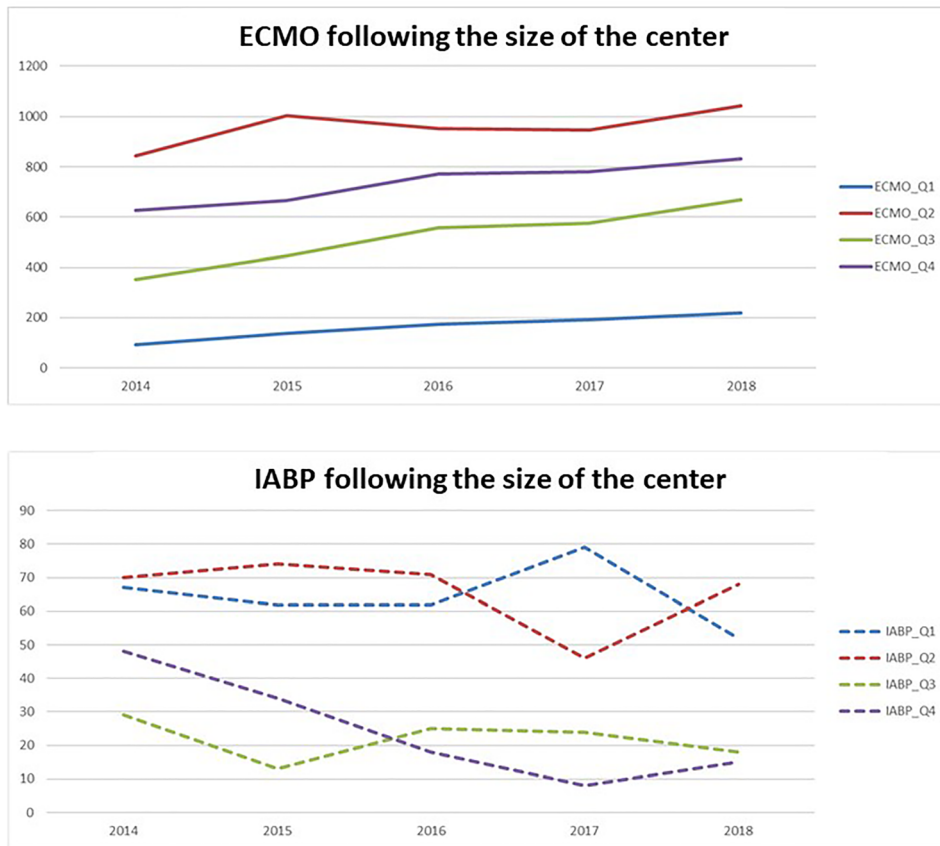
Importantly, despite decrease in IABP implantation, total mechanical support implantation remained constant over the years. Indeed, ECMO implantations significantly increased over the years. ECMO may offer an appealing support as this technique proved its efficacy in CS,⁷ especially in the case of biventricular dysfunction. However, ECMO is available only in selected “level 3” centres,⁸ limiting its utilization in routine. In our study, ECMO utilization mainly increased in large centres with cardiac surgery that may correspond to those “level 3” centres. Perhaps this stable total use of assist device could reflect the maximal use in large tertiary centres because of limited means.

Alternatively, these devices could be used in different ways depending on the kind/size of centres but also because of the

target. IABP and ECMO are indeed very different in the principle of function and should therefore have somewhat different indications and uses (apart from the lately class III recommendation for IABP). There are conditions of pulseless activity in cardiogenic shock, where ECMO could be life-saving while IABP may not suffice. Other assist devices are needed such as a bridge to potential recovery, thus saving the ECMO for more serious situations with completely inadequate heart pump function. Above all, ECMO is more complicated to use than IABP, but its use is expected to have been expanding in the last years because of the need of ECMO in certain circumstances and not necessarily because the alternative (IABP) is not anymore recommended. On the other hand, IMPELLA® may offer an attractive alternative to IABP. However, because the cost of this device is not reimbursable in France, its utilization is largely limited, totalling around 2% of patients in our study and not increasing over the years.

Finally, IABP is used not only by little centres unable to provide ECMO but also by large centres with surgery and high-volume activity, suggesting that other indications remain (high-risk patients awaiting coronary artery bypass,

Figure 4 ECMO and IABP implantations according to the size of the centre in terms of beds. Centres were divided into four quartiles according to the number of beds, with Q1 as the smaller number of beds and Q4 as the most important number of beds. ECMO, extracorporeal membrane oxygenation; IABP, intra-aortic balloon pump.



post-cardiotomy shock, mechanical complications of acute myocardial infarction, temporary assist device after surgery, etc.).

other words, the representation of cardiogenic shock and means used to fight this very severe condition appears by far more complex than initially expected, suggesting the need for more detailed studies including real-life registries such as the FRENHOCK registry (NCT02703038).

Conclusions

In this nationwide real-life study, despite a significant decline in IABP implantations over the years since the ESC guideline, this device remains widely used in clinical practice with a decrease in IABP implantations less important than expected. In

Conflict of interest

None declared.

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